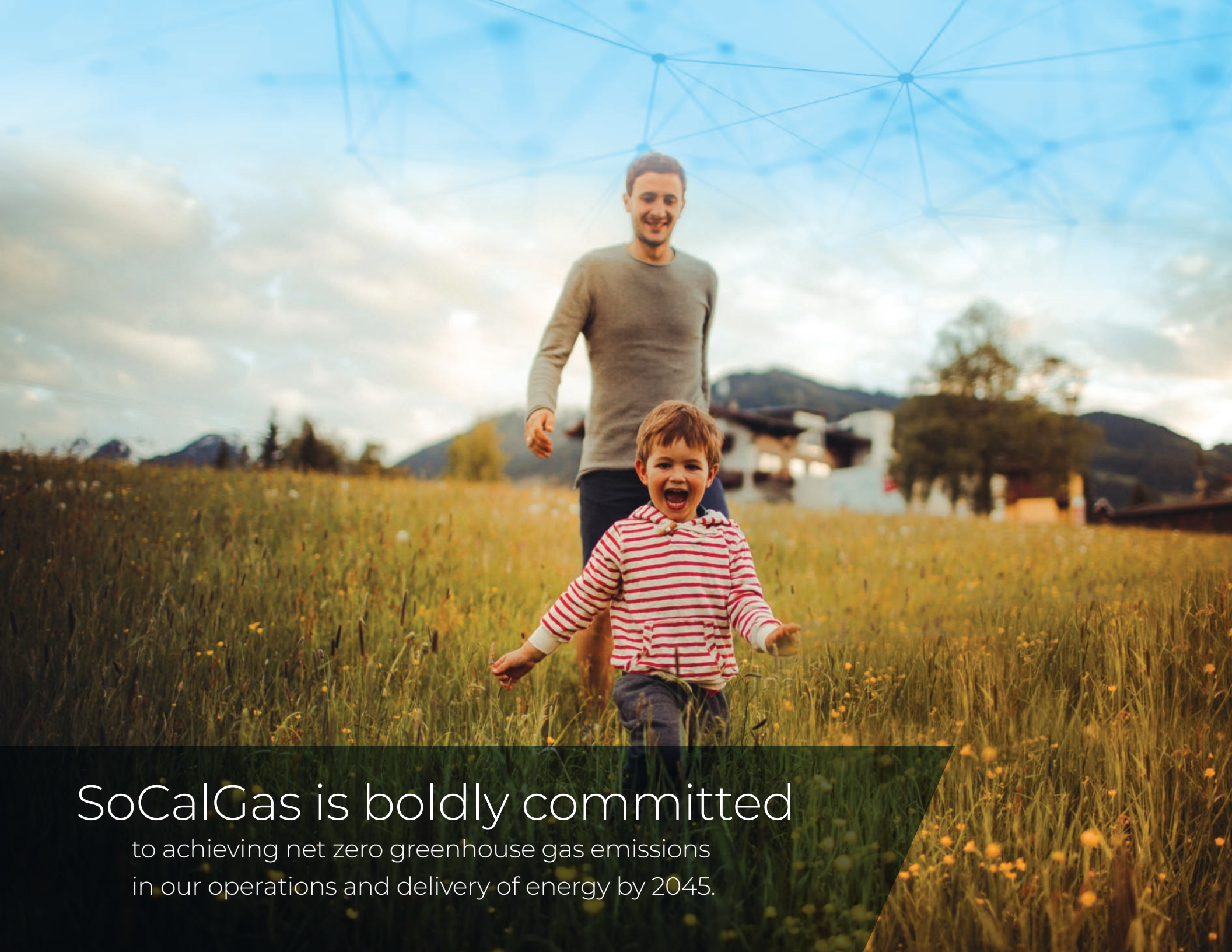
Transitions

RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROGRAM 2020 ANNUAL REPORT

SoCalGas
A Sempra Energy utility®



SoCalGas is boldly committed

to achieving net zero greenhouse gas emissions
in our operations and delivery of energy by 2045.

Innovation

and the rapid development of new technologies will be vital to our success.

The SoCalGas Research, Development, and Demonstration Program

plays a key role in this effort by developing and demonstrating transformational products and technologies that promote decarbonization across the natural gas value chain and a diversified portfolio of clean energy sources, distributed networks, tools, and applications.

"With reliance on renewable energy sources growing every year, the decarbonization of the energy sector is well underway.

SoCalGas is playing a pivotal role in this transformation by developing clean energy innovations and energy efficiency technologies as well as advancing hydrogen for use in both transportation and energy storage."

MARYAM BROWN
President
SoCalGas

The vision, mission, and values of the SoCalGas Research, Development, and Demonstration Program align with SoCalGas' mission to build the cleanest, safest, and most innovative energy company in America.

OUR VISION

Advancing innovative technologies for safer, cleaner, and more reliable energy.

OUR MISSION

Identify transformational energy solutions. Build them. Share them with the world.

OUR VALUES

Science
Our experts in science, engineering, energy systems, and environmental policy seek answers to some of today's most pressing energy questions.

Synergy
We work with the world's finest researchers in universities, national labs, and industry to develop transformational technologies that support decarbonization, energy security, and economic development.

Equity
We champion technologies that support affordable access to clean, safe, and reliable energy for all Californians.

PROGRAM BENEFITS

OPERATIONAL EFFICIENCY
157 PROJECTS

RELIABILITY
226 PROJECTS

SAFETY
199 PROJECTS

ENVIRONMENTAL:
IMPROVED AIR QUALITY
187 PROJECTS

ENVIRONMENTAL:
REDUCED GHG EMISSIONS
229 PROJECTS

IMPROVED AFFORDABILITY
144 PROJECTS

2020

A YEAR OF TRANSITIONS

"Oil and gas [have] incredible infrastructure, incredible capacity to move energy from one place to another... What if that happened for hydrogen?"

—JOHN KERRY
SPECIAL PRESIDENTIAL ENVOY FOR CLIMATE

2020 was a year of transitions. The global COVID-19 pandemic brought sickness and tragedy into many lives and upended how we live, work, and play. For a time, modern life ground to a halt. Amidst the chaos, however, science, technology, and innovation were powerful forces that helped us adapt to the changes and come together as a community.

Digital collaboration tools brought families, friends, students, and co-workers together when they could not meet in person. Restaurants, grocery stores, and retailers began offering online ordering and curbside pickup. And around the world, teams of scientists and researchers worked day and night to develop effective vaccines against the coronavirus at a record-breaking pace.

At SoCalGas, we believe that science, technology, and innovation—as well as collaboration—can help solve another one of the world's great challenges: climate change.

According to the International Energy Agency, global carbon dioxide emissions were expected to decline by a record 8% in 2020. Unfortunately, most of this reduction was driven by a temporary reduction in demand for energy rather than by real, large-scale structural changes to how we produce and utilize it. Supporting meaningful progress in the transition to lower-carbon forms of energy while ensuring safe, reliable, and affordable access to it are key goals of the SoCalGas Research, Development, and Demonstration (RD&D) Program.

THOUGHT-LEADERS, INNOVATORS, AND INDUSTRY EXPERTS

"Almost any objective analysis for getting to zero emissions includes hydrogen."

—JACK BROUWER
DIRECTOR
NATIONAL FUEL CELL RESEARCH CENTER
UNIVERSITY OF CALIFORNIA, IRVINE

With more than 21 million customers and one of the nation's largest networks of gas transmission, storage, and distribution infrastructure, SoCalGas is well-positioned to play a central role in the ongoing decarbonization of our energy industry and, ultimately, the state of California.

The RD&D Program is staffed with subject matter experts in science, engineering, industrial process technology, and environmental policy who collaborate with the world's top institutions—including the U.S. Department of Energy (DOE), the National Renewable Energy Laboratory (NREL), the California Energy Commission (CEC), Gas Technology Institute (GTI), Caltech, the University of California, and Stanford University—to develop and demonstrate transformational products and technologies that promote decarbonization across the entire natural gas value chain.

We communicate regularly with our colleagues around the nation and world, ensuring that the work we support supplements and complements their efforts and addresses the most pressing technological gaps in the field.

Each year, we support hundreds of projects along the commercialization pathway—from lab-scale R&D to multi-year precommercial demonstrations—with the ultimate goals of saving energy, reducing GHG emissions, improving air quality, and increasing energy safety, reliability and affordability.

And, when we finish a project, our work is not done. We share "lessons learned" widely to spur further innovation and advance products from lab- and demonstration-scale to market. In support of these goals, the RD&D Program invested almost $15 million in energy technology projects in 2020.

CLEANER, MORE AFFORDABLE, & SAFER ENERGY FOR ALL

"I'm going to work with my new advisor for equity so that we can lead the way—by targeting disadvantaged communities for new clean energy investments, jobs, and businesses, doubling down on our commitments to racial justice, and developing policies that ensure the benefits of this emerging economy reach those on the front lines of climate change."

—SECRETARY JENNIFER GRANHOLM
U.S. DEPARTMENT OF ENERGY

Science and technology helped many navigate the trials of the past year. But too many people have been left behind or never experienced the benefits of abundant energy and a prosperous economy in the first place. In California, millions of people live and work in areas categorized as Environmental or Social Justice (ESJ) communities, a designation that includes disadvantaged communities, tribal lands, and low-income households and census tracts.

All too often, people from ESJ communities suffer disproportionate environmental and socioeconomic impacts, including poverty, high unemployment, air and water pollution, and high incidences of asthma and heart disease. In many cases, ESJ community residents also suffer from reduced or less reliable access to energy. What energy they can access often represents a burdensome percentage of their household incomes.

The RD&D Program seeks to advance and champion technologies that support widespread access to clean, affordable, and reliable energy for all Californians, including those living and working in ESJ communities.

That is why equity is a factor we consider when deciding which products and technologies to support. Our short-term goals are to increase our engagement with residents and businesses from ESJ communities and to continually grow the number of projects we support in those locations. Ultimately, we want to ensure that the benefits of decarbonization and clean energy do not become luxuries for the wealthy but are widely available and accessible to all Californians.

2020 EQUITY ACTIVITIES

We committed to **long-term relationship building** with key representatives of ESJ communities throughout California.

We prepared educational material about the RD&D Program for members of ESJ communities and, in collaboration with the Regional Public Affairs (RPA) team, co-launched our **ESJ outreach program**, identifying approximately 20 community-based organizations (CBOs) to target for 2021 presentations.

Our commitment to provide customers with safe, affordable, and reliable service goes beyond natural gas. We are also dedicated to **improving the quality of life in the communities we serve** by maintaining a diverse workforce and giving back through our charitable contributions and employee volunteer activities.

We **connected one-on-one** with organizations—including Hispañas Organized for Political Equity (HOPE)—in ESJ communities and sought input on potential research needs.

We began working with the SoCalGas Supplier Diversity group to identify resources available to **help diverse and minority-owned businesses** connect and work with SoCalGas RD&D. Supplier diversity can help culturally and ethnically diverse business owners navigate the paperwork required to obtain certification by the California Public Utilities Commission (CPUC) as a Diverse Business Entity (DBE).

We committed to **supporting supplier diversity** and actively sought collaboration with disadvantaged business enterprises and woman-, LGBTQ-, and disabled-veteran-owned businesses.

We interviewed experts, including researchers at the University of California, Los Angeles (UCLA) Luskin Center for Innovation and a Senior Equity Analyst at the CPUC, to seek guidance on developing the RD&D Program's **Equity Engagement Plan**.

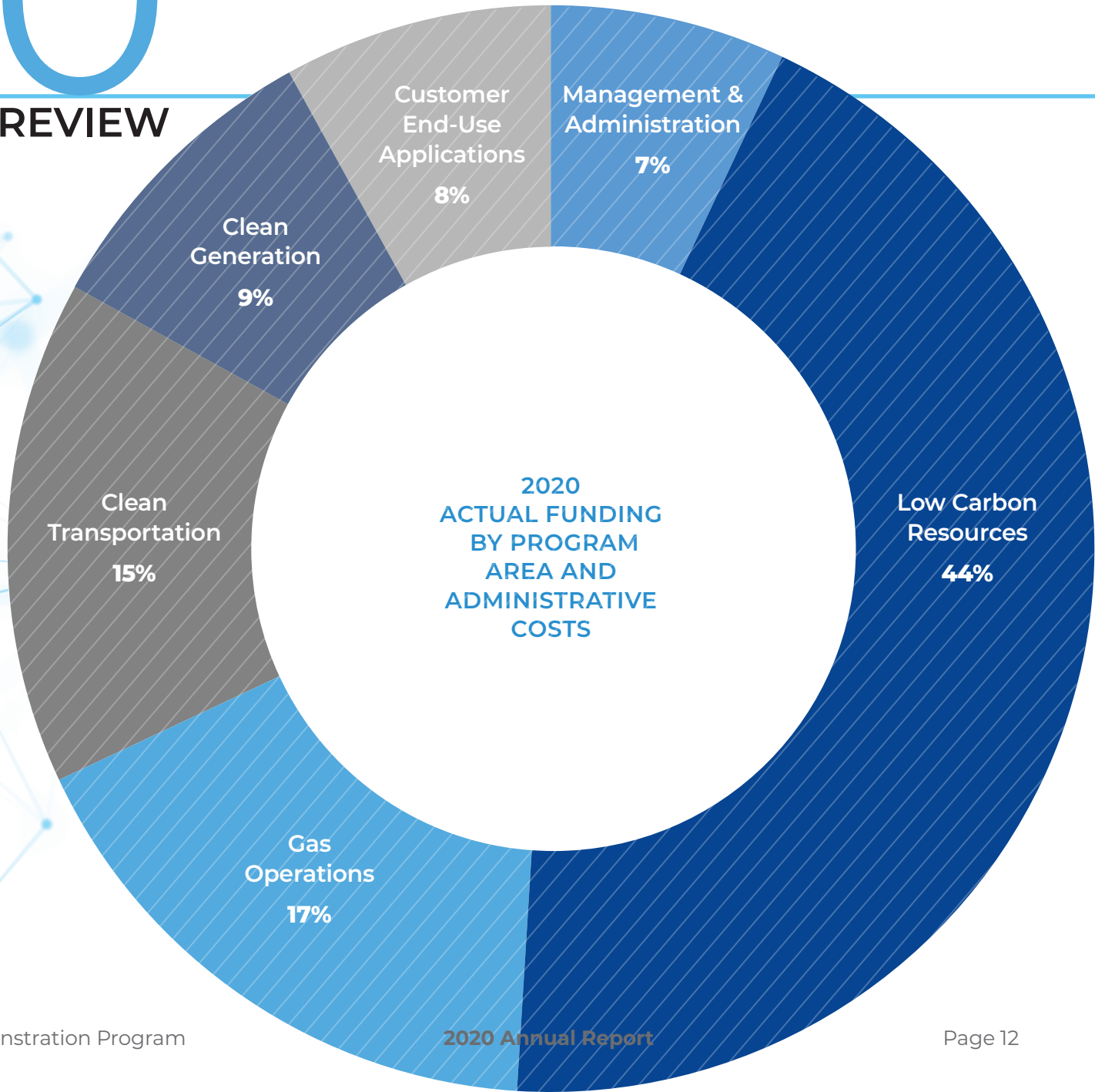
Based on feedback submitted during our 2020 public workshop, RD&D staff started developing an **Equity Engagement Plan**. Like the other transitions we experienced in 2020, equity engagement is a new area for the RD&D program. At this early stage of development, the plan is devoted to connecting with and listening to stakeholders in ESJ communities.

2020 IN REVIEW

FINANCIAL HIGHLIGHTS

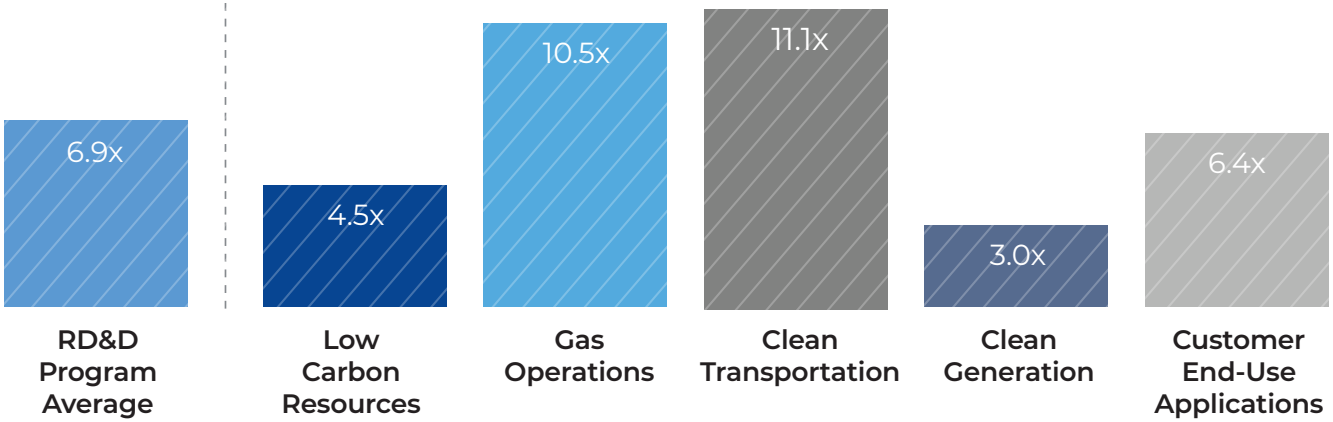
In 2020, the RD&D Program supported 386 active RD&D projects and distributed almost $15 million to projects across the entire gas value chain in California.

In executing these projects, SoCalGas collaborated with many of the most forward-thinking research consortia, universities, national labs, public agencies, and entrepreneurs in the nation and the world. Collectively, these organizations provided significant leveraged funding, as well as invaluable guidance, review, technical expertise, and access to resources and infrastructure.



Split across five program areas—Low Carbon Resources, Gas Operations, Clean Transportation, Clean Generation, and Customer End-Use Applications—these projects encompassed everything from benchtop research efforts and pilot testing to demonstrations in real-world conditions. Importantly, they achieved substantial progress toward commercializing new safe, reliable, and affordable clean energy products and technologies.

RATIO OF OUTSIDE FUNDING TO SOCALGAS FUNDING



2020 Funds Expended

In 2020, the SoCalGas RD&D Program invested $14,894,000 in numerous projects across the entire gas value chain. The RD&D Program allocated funding across the five programs and multiple subprograms. Collectively, these projects leveraged significant cofunding from businesses, research consortia, and other participating organizations. On average, every dollar of SoCalGas RD&D funds expended was matched by $6.90 of funding from other sources in 2020.

PROGRAM	2020 ACTUALS
Low Carbon Resources	$7,036,000
Gas Operations	$2,677,000
Clean Transportation	$2,363,000
Clean Generation	$1,442,000
Customer End-Use Applications	$1,376,000
Management & Administration	$1,149,000
TOTAL	**$16,043,000**

Royalties and Incentives

To maximize value, the RD&D Program is authorized to negotiate royalty and equity arrangements with companies participating in the program. For certain products or technologies nearing full commercialization, SoCalGas negotiates product royalty rights or equity interest in companies developing targeted technologies in exchange for RD&D funding used to support technology development and demonstration. When appropriate, SoCalGas may also negotiate post-commercial benefits on equipment and other technology developed with funding from the RD&D Program.

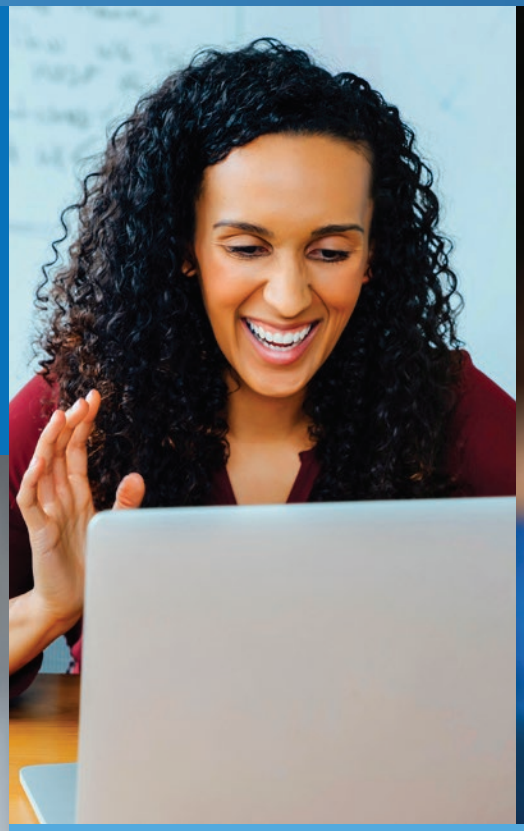
These arrangements provide an opportunity for SoCalGas ratepayers to receive a direct financial return should the technology development efforts prove successful. In 2020, past RD&D Program investments generated $132,359 in royalties.

PROGRAM	2020 ACTUALS
2015	$99,689
2016	$90,882
2017	$104,398
2018	$100,849
2019	$99,584
2020	$132,359

SIGNIFICANT 2020 MILESTONES

2020 ANNUAL STAKEHOLDER WORKSHOP:

On April 24, 2020, RD&D Program staff hosted an online workshop attended by 148 individuals from a wide variety of organizations, including the CEC, GTI, HOPE, NREL, the University of California, and the National Fuel Cell Research Center. Program staff incorporated input received at the workshop into the 2021 RD&D Program Research Plan.



TOTAL ACTIVE PROJECTS IN 2020

386

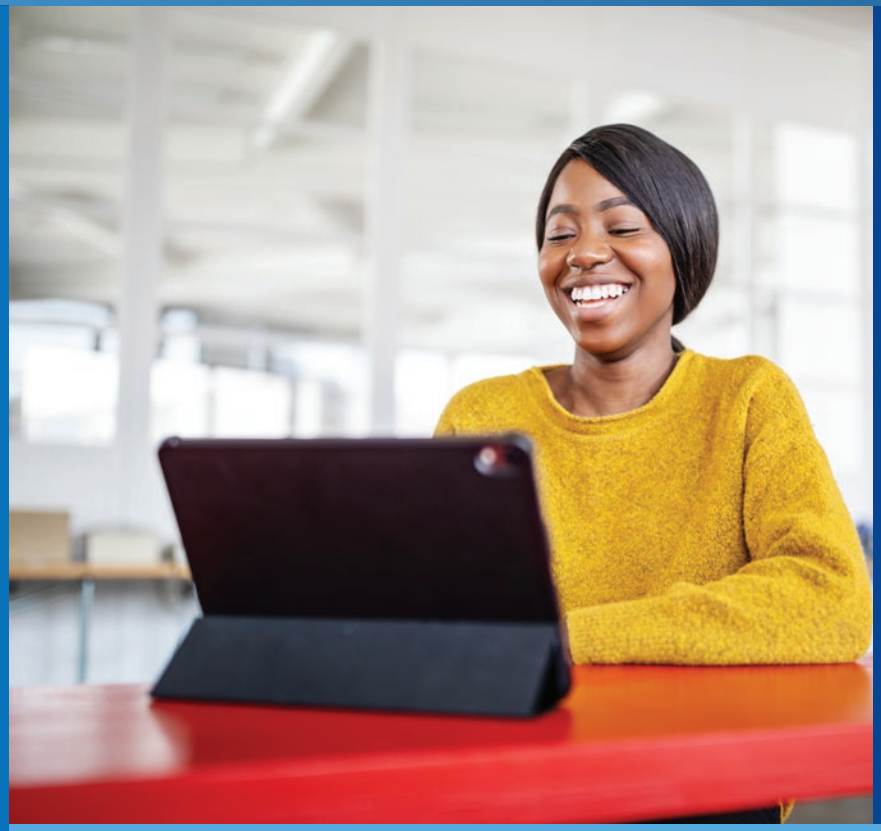
SIGNIFICANT 2020 MILESTONES

Research Webinars

RD&D Program staff conducted two webinars to share information with industry stakeholders, the research community, and the general public about two recent successful projects. Recordings of the webinars are available on the SoCalGas RD&D webpage.

The first, a collaboration with Opus 12, explored how to utilize carbon dioxide emissions to produce renewable fuels and industrial chemicals. Among the 50 attendees were representatives from Lawrence Livermore National Laboratory, the American Gas Association, the National Aeronautics and Space Administration, and the Pipeline Research Council International (PRCI).

The second discussed a recent joint effort with GTI to develop a 4th-generation gas-fired heat pump water heater that reduces GHG emissions by 49% in comparison with conventional gas-fired water heaters. The 42 attendees included representatives from Pacific Northwest National Laboratory (PNNL), Rinnai, and Northwest Energy Efficiency Alliance.

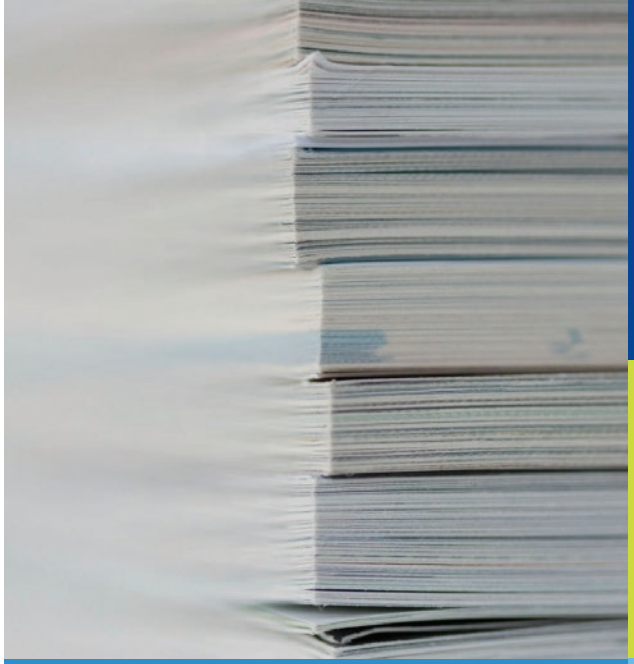


TOTAL INITIATED PROJECTS IN 2020

104

106

TOTAL PROJECTS COMPLETED IN 2020



LEVERAGED PUBLIC FUNDING

In 2020, program staff supported 19 proposals applying for public funding. These projects were awarded more than $38 million in research funding from the DOE, CEC, and the National Science Foundation.

5 PROJECTS WON A TOTAL OF **$11,922,984** FROM CEC IN 2020

PUBLICATIONS, PATENTS, AND CITATIONS

In 2020, projects cofunded or otherwise supported by the RD&D Program were featured in 55 articles, reports, and technology briefs. Projects supported by the RD&D Program were also associated with four patent applications.

See Appendix for more information.

DEPLOYED TECHNOLOGIES

A major goal of the RD&D Program is to bring technology from the lab to market. In 2020, organizations across California and throughout the nation deployed numerous products and technologies for real-world use as a direct result of the support they received from the RD&D Program. Examples from 2020 include:

- Fracture Toughness via in-Ditch Non-Destructive Testing-Validation (NDE-2-9)
- Polyethylene Saddle Heat Fusion Rounding Clamp Evaluation
- Fiber Optical Systems at Montecito Creek
- Risk Profile for Aldyl-A Piping System - Phase 3 –Squeeze Off Reinforcement Clamps (2.13.d.3)
- Small Polyethylene Diameter Squeeze-Off - Phase 2 (2.14.c.2)
- Gas Utility Threat Contextualization (Real-Time Visualization and Notification)
- Demonstrate In-Line Inspection Tool for Gas Storage Piping
- Heavy Hydrocarbon Compound Dew Point in Natural Gas Pipelines (MEAS-15-01)
- Protect Tracer Wires from Corrosion (5.17.k)

Program

GOALS AND STRUCTURE

Improve the environment

Develop renewable resources

Improve safety, reliability, affordability

PROGRAM GOALS

The goals of the RD&D program are to identify, test, and commercialize transformational new energy technologies that will reduce GHG and criteria air pollutant emissions, maintain the energy affordability that natural gas has historically provided, and advance the safety and reliability of California's gas delivery networks and systems in an ever-changing operational environment.

Concurrent with the pursuit of these goals, SoCalGas also seeks to decarbonize its pipeline by replacing conventionally sourced, fossil-based natural gas with increasingly higher amounts of renewable natural gas (RNG) and hydrogen to benefit its customers and support California in the achievement of its ambitious climate change goals.

Consistent with the framework established in Public Utilities Code Section 740.1, program staff considers multiple factors when selecting projects to support. These factors include regulatory and policy drivers, input from knowledgeable industry stakeholders, equity, and corporate policy and goals, such as 20% RNG being delivered in our system by 2030.

PROGRAM STRUCTURE

In 2020, the RD&D Program allocated funding across five research program areas: Low Carbon Resources, Gas Operations, Clean Transportation, Clean Generation, and Customer End-Use Applications.

PROGRAM STRUCTURE

The five program areas and their respective sub-programs:

Gas Operations

- Environmental & Safety
- Operations Technology
- System Design & Materials
- System Inspection & Monitoring

Low Carbon Resources

- Renewable Gas Production
- Low Carbon Hydrogen Production
- Low GHG Chemical Processes

Clean Transportation

- On-Road
- Off-Road
- Refueling Stations
- Onboard Storage

Clean Generation

- Distributed Generation
- Integration & Controls

Customer End-Use Applications

- Commercial Food Service
- Residential Applications
- Commercial Applications
- Industrial Process Heat
- Advanced Innovation

The RD&D Program follows three SoCalGas principles in its quest to achieve California's energy transition and net zero goals.

1

DECARBONIZATION

Reducing carbon intensity across all economic sectors is foundational to achieving net zero. It requires energy efficiency, renewable electricity, renewable gases, long duration storage, carbon management, and other technologies to be viable at scale.

2

DIVERSIFICATION

Developing a diversified portfolio of clean energy sources, distributed networks, tools, and applications is the only way to achieve society's clean energy goals. Diversification also serves as a necessary risk management tool, delivering resiliency to the system and protecting against the uncertainties of the future.

3

DIGITALIZATION

Deploying advanced technologies and analytics to improve planning, safety, resiliency, and the integration of real-time information to benefit participants across the energy value chain.

RESEARCH COLLABORATORS

"Decarbonized gas would let us take advantage of trillions of dollars of existing pipelines, equipment, and appliances, saving huge sums of money and years of time in creating a zero-carbon energy system."

—MICHAEL WEBBER
SCIENTIFIC AMERICAN

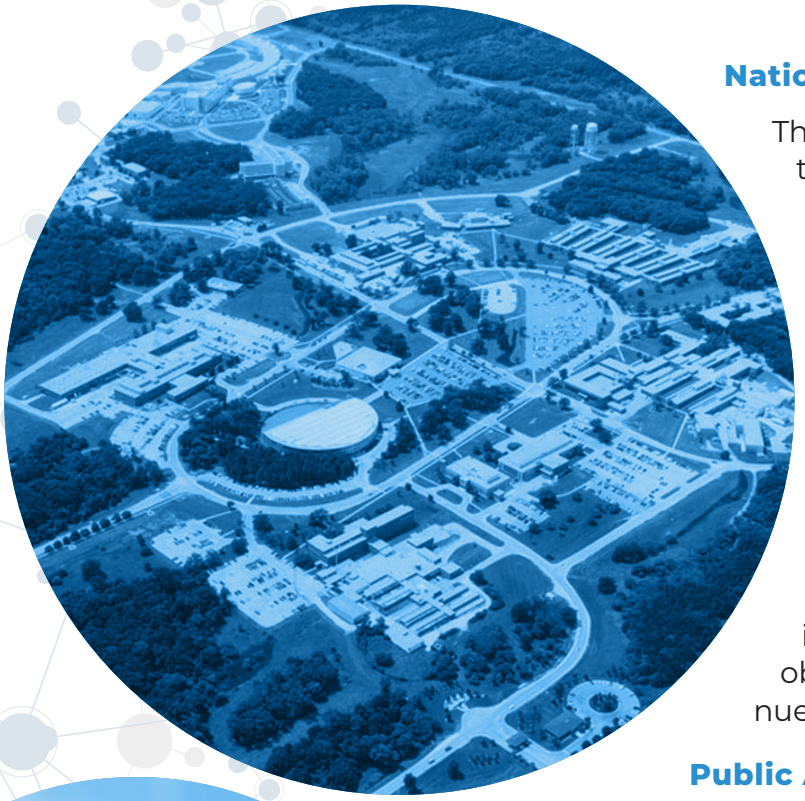
The SoCalGas RD&D Program is a vital element of a much larger technology funding ecosystem that includes a variety of gas industry research consortia and numerous federal, state, and regional public agencies. Program staff works with leading industry professionals and subject matter experts from these organizations, as well as from universities, national labs, and businesses, to maximize the impact of their investments in promising technologies and products with clear commercialization pathways.

These relationships enable SoCalGas to engage science and technology experts, other utilities, and industry stakeholders in open dialogues to more effectively identify and close knowledge and research gaps, avoid duplication of previous and ongoing research, and mitigate technical, economic, and commercialization risks. This helps us in our quest to develop products and technologies that reduce customer costs, save energy, increase safety and reliability, improve air quality, and reduce GHG emissions.

Together, we exchange information and research concepts, collaborate on project development, establish partnerships, and actively seek public and private funding opportunities, with the goals of securing additional cofunding and assembling the most capable and impactful team of subject matter experts to work on any particular project.

Universities

SoCalGas regularly collaborates with scientists, engineers, and other academics at some of our nation's most prominent universities, including Stanford University, the California Institute of Technology (Caltech), and the University of California at Davis, Riverside, and Irvine. These professionals perform fundamental science work through lab- and bench-scale applied research on a variety of critical energy topics, including fuel cell development, carbon-free hydrogen production and energy storage, and carbon capture and use. University collaborators also possess expertise in modeling, technoeconomic analysis, and lifecycle analysis—areas of immense importance to the evaluation, development, and demonstration of cleaner, safer, affordable, and more reliable energy solutions. On many projects, universities also serve as ideal technology demonstration sites.



National Laboratories

The U.S. National Laboratories and Technology Centers are a system of facilities and laboratories overseen by the DOE to advance science and technology. Researchers and scientists at the 17 national labs tackle the critical scientific challenges of our time—from combating climate change to discovering the origins of our universe—and possess unique instruments, equipment, and testing facilities.

National labs are unequaled in their ability to address large-scale, multifaceted, and complex research and development challenges with a multidisciplinary approach that emphasizes translating basic science to innovation. SoCalGas regularly engages national lab personnel for subject matter expertise, guidance, and collaboration in developing and executing research projects. Through collaboration with national labs, SoCalGas often cofunds projects supported by the DOE, amplifying the impact of RD&D funds for maximum leverage. In many cases, SoCalGas also obtains licensing or intellectual property (IP) rights, which can generate revenue and offset RD&D Program costs.

Public Agencies

At local, state, and federal levels, public agencies play a key role in driving the RD&D process, from disseminating project solicitations related to regulatory policy objectives to serving as thought leaders that help shape broad energy strategies. RD&D Program staff regularly work with numerous agencies, including the DOE, CEC, South Coast Air Quality Management District, the California Air Resources Board, and the Pipeline and Hazardous Materials Safety Administration (PHMSA).

For projects focused on early-stage technologies, public funding programs can significantly reduce many of the risks associated with deploying staff and resources on untested products. This, in turn, can attract high-caliber team members and other leveraged funding to compound the impact of invested dollars. Importantly, if successful, publicly funded projects can serve as springboards to additional public and private funding, larger demonstration projects and, ultimately, product and technology commercialization.

Businesses

At its core, the RD&D Program is about developing and promoting practical applications to overcome challenges facing the energy sector, in alignment with California's decarbonization goals. To help ensure that the new technologies and products supported by SoCalGas advance to real-world applications and markets, RD&D Program staff leverage their connections, knowledge, and expertise by working closely with leading equipment manufacturers and global technology developers to demonstrate new technologies in large-scale and/or long-term pilot demonstration projects under real-world conditions. These demonstrations constitute the final stages of validation before commercial launch.

Research Consortia

RD&D Program staff have developed strong ties with several research consortia focused on the gas energy industry. The membership of many of these organizations consists of utility companies across North America. Typically, these consortia serve member utilities by facilitating technical collaboration and pooling financial and technical resources to collectively address ongoing or anticipated challenges in the gas industry.

By working closely with these and other similar organizations, RD&D Program staff can share both knowledge and funding with other utilities and researchers to develop and execute impactful projects. Coordination of work between these organizations and access to technical libraries also greatly reduce the odds of reproducing previously completed work or work currently underway.

To facilitate collaboration with research consortia, the RD&D Program is a member of five subscription-based organizations: Northeast Gas Association (NGA)/NYSEARCH, Operations Technology Development (OTD), PRCI, Sustaining Membership Program (SMP), and Utilization Technology Development (UTD).

Northeast Gas Association/NYSEARCH: NGA/NYSEARCH is a collaborative research suborganization within the Northeast Gas Association that serves 20 gas utility member companies. Members of NYSEARCH, primarily North American gas distribution companies, voluntarily participate in projects focused directly on needs specific to the member companies and the gas industry as a whole.

Operations Technology Development: OTD is a not-for-profit organization, comprising 26 gas utility members that serve over 60 million gas consumers in the United States and Canada, representing 75% of the households served by gas. OTD combines the interests, expertise, and resources of its members to develop advanced operations and pipeline technologies for the gas industry.

Pipeline Research Council International: PRCI is a community of the world's leading pipeline companies, vendors, service providers, equipment manufacturers, and other organizations supporting the gas industry. PRCI's research focuses directly on gas and oil transmission pipeline issues.

Sustaining Membership Program: SMP is a collaborative research and development program with two segments, Utilization and Operations. Its 28 gas utility members support research projects focused on gas delivery, energy utilization, environmental science, and renewable energy. SMP develops technology through the "proof of concept" phase, at which point the most promising technologies are continued through short- to mid-term R&D programs, implemented by organizations such as OTD and Utilization Technology Development (UTD).

Utilization Technology Development: UTD is a 20-member consortium of utilities in the United States and Canada, representing 37 million gas customers in North America. Its goal is to develop new technologies that help gas consumers save money, reduce emissions, improve efficiencies, and optimize their gas use.

See Appendix for more information.

Programs

LOW CARBON RESOURCES

The primary goal of the Low Carbon Resources program area is to decarbonize the gas supply while maintaining its affordability and reliability. To accomplish this goal, program staff members develop, promote, and advance new technologies aimed at increasing and expanding the production of renewable gas to displace conventionally sourced pipeline gas, while also limiting or recycling GHG emissions.

This program includes three subprograms:

Renewable Gas Production

This subprogram focuses on the safe, reliable, and cost-effective production of renewable gaseous fuels—specifically, RNG and hydrogen—from various feedstocks and multiple technological pathways. Areas of focus include, but are not limited to, biomass processing and conversion, renewable hydrogen production from direct water splitting, and methanation pathways to produce RNG from captured carbon dioxide.

Low-Carbon Hydrogen Production

This subprogram focuses on the production of low-carbon and emissions-free hydrogen from various methane feedstocks, including biomethane. Areas of focus include, but are not limited to, advanced steam methane reforming (SMR) and methane pyrolysis technologies.

Low-GHG Chemical Processes

This subprogram focuses on the design, development, and deployment of technologies that can minimize reliance on natural gas combustion, and on carbon capture utilization and sequestration (CCUS) technologies for the capture of GHG emissions and their conversion into valuable chemicals or sequestration.

Low Carbon Resources
SPOTLIGHT

INNOVATIVE PROCESS MAKES CLEAN CEMENT AND LOW- OR ZERO-CARBON HYDROGEN

New industrial process coproduces hydrogen and cementitious materials in a clean, cost-effective manner that also reduces energy consumption.

Industrial processes account for a significant portion of global GHG emissions, with four processes in particular—cement, hydrogen, steel, and aluminum production—accounting for roughly 16% of the annual total. These four carbon-intensive processes are particularly difficult to decarbonize because they use tremendous amounts of energy, resulting in large quantities of process emissions.

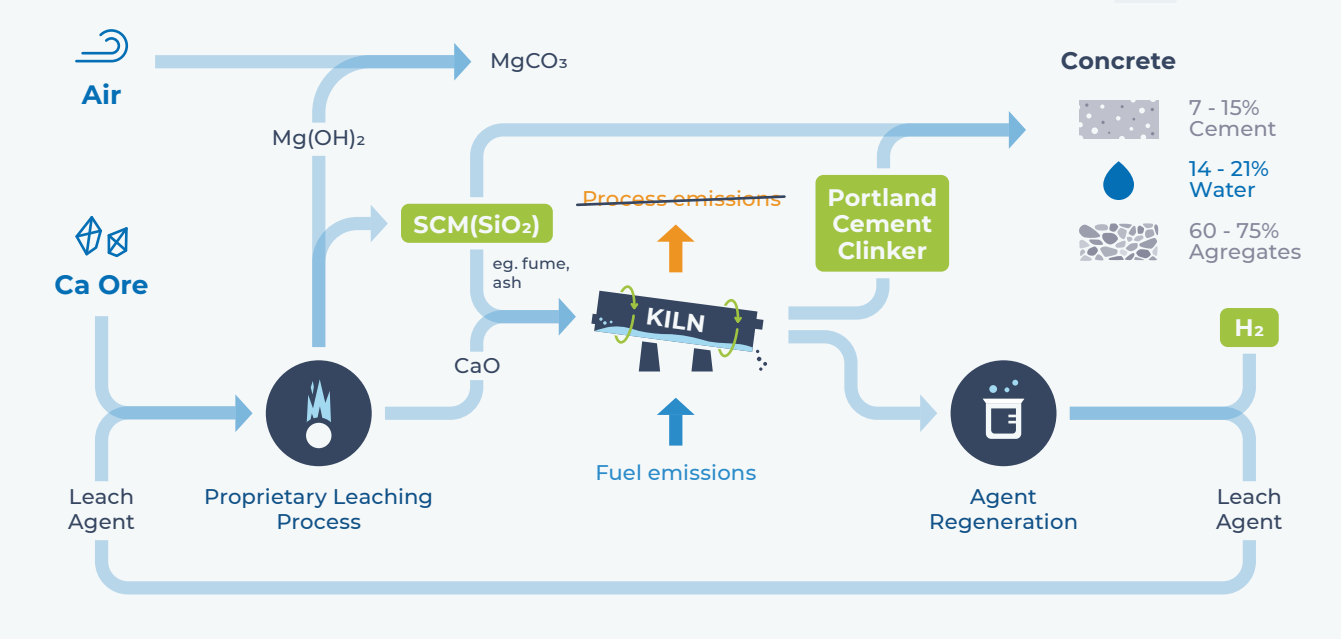
Recently, SoCalGas collaborated with Brimstone Energy on the development of a prototype system that, once fully commercialized, could dramatically reduce GHG emissions from two of these four major emitters, hydrogen and cement. The prototype builds on earlier proof-of-concept work completed by Brimstone's founders while completing graduate research at Caltech.

TOTAL PROJECT COST	$3,525,000
SOCALGAS	$50,000
COFUNDING	$3,475,000

"Cement turns into concrete which is the most widely used material on the planet," explained Cody Finke, CEO of Brimstone. "There is also tremendous industrial demand for hydrogen." Collectively, the production of these two commodities accounts for roughly 3% and 8%, respectively, of annual global GHG emissions.

"Cement today is typically produced from limestone—CaCO3—which is essentially solidified carbon dioxide," said Finke. "When you heat limestone, it releases carbon dioxide. So, even if the energy used to produce cement is 100% clean,

Brimstone Energy sought to develop a batch-process system sulfuric acid electrolysis prototype capable of producing 1 kg of clean hydrogen, while consuming less energy than a comparable conventional water-only electrolysis process.



The new process does not start with calcium carbonate or natural gas and, thus, does not emit process carbon emissions. The only potential emissions associated with the technology depend on the source of the energy used to power the system.

the majority of emissions associated with concrete production would persist."

The same is true for conventional hydrogen production, which most commonly uses steam methane reforming (SMR). "Basically, you heat up natural gas—methane or CH4—in the presence of steam and it decomposes into hydrogen and carbon dioxide," said Finke. "Again, even if the energy used to power SMR is completely carbon-free, you would still produce a lot of carbon dioxide."

"The only way to decarbonize these industries is to improve their economics while lowering the associated emissions," said Finke. "That's why we developed an industrial process that can co produce both hydrogen and cementitious materials in a clean, cost-effective manner that also reduces energy consumption."

"Essentially, the system uses sulfuric acid (H2SO4) to dissolve a calcium ore, which selectively extracts calcium sulfate (CaSO4) and produces supplementary cementitious materials, such as ash and silica fume," said Finke. The system then heats the calcium sulfate in a kiln, which produces sulfur dioxide (SO2) and cement. "Finally, it combines the supplementary cementitious materials produced earlier with clinker to produce low-carbon concrete."

To produce hydrogen, the system inputs the sulfur dioxide produced in the kiln and water into an electrolyzer, which produces hydrogen and sulfuric acid. The sulfuric acid is then recycled as an input into the cement production process described above.

"We don't start with calcium carbonate, so there are no emissions in the cement-making process," said Finke. "We don't start with natural

gas, so there are no emissions from the hydrogen production step." The only potential emissions associated with the technology depend on the source of the energy used to power the system.

In its collaboration with SoCalGas, Brimstone Energy sought to develop a batch-process system sulfuric acid electrolysis prototype capable of producing 1 kilogram (kg) of clean hydrogen, while consuming less energy than a comparable conventional water-only electrolysis process. "This exact electrolytic reaction has never been built at industrial scale before," said Finke. "To better understand how to scale up, we plan on performing a lot of stability testing to ensure consistent energy consumption per unit of hydrogen produced."

The next goal is to gather data for the near-term development of a skid-mounted, continuous-process pilot system capable of producing several kilograms of cement per day and tens of grams of hydrogen at an industrial facility. "If that proves successful, we hope to build a full-scale demonstration plant sometime in 2023," said Finke.

As a small startup, Brimstone Energy initially had difficulty raising capital. With a contribution of $50,000, SoCalGas' RD&D Program was the first organization to support Brimstone and recognize the technology's potential. Leveraging that initial funding, Brimstone has since raised almost $4 million from a variety of organizations, including Pacific Gas and Electric, Caltech's Rocket Fund, the Chevron Catalyst Program, the DOE's Advanced Research Projects Agency-Energy (ARPA-E) program, as well as additional private venture capital investors. The company also gained access to free lab space through a grant from the DOE and Cyclotron Road, a program that incubates advanced technologies in partnership with Lawrence Berkeley National Laboratory.

The process has incredible potential. Brimstone estimates that in a system configuration that uses solar- or wind-generated electricity and heat from natural gas, the carbon intensity of the process would be approximately 30 kg carbon dioxide per ton of cement produced along with 25 kg of hydrogen co-production. "To put that in perspective, using the same assumptions, a conventional approach would have a carbon intensity of roughly 1,000 kg of carbon dioxide per ton of cement produced," said Finke. Using clean electricity and renewable natural gas, Finke estimates that carbon intensity would further drop to approximately -620 kg of carbon dioxide per ton of cement produced.

The new process has one additional benefit. "Carbon emissions really depend on the rock we start with," said Finke. Brimstone has chosen to work with a rock common to California, where the company is based. This rock is particularly rich in magnesium, which delivers additional environmental benefits. "One of the waste products of our process is magnesium dihydroxide, which naturally sucks carbon out of the atmosphere and converts it to magnesium carbonate. So even when the process uses heat from natural gas, there is a built-in mechanism for carbon capture."

Finke anticipates participating in joint ventures with cement companies, concrete companies, or gas utilities in the future. "Our products would be clean cement and low- or zero-carbon hydrogen, depending on the source of electricity used in the electrolyzer," said Finke. "If the entire cement industry used this process to produce 100% of the world's cement, then we would produce enough hydrogen to fuel all of the world's cars."

Low Carbon Resources
SPOTLIGHT

NEW CO2-FREE PROCESS PRODUCES HYDROGEN FROM NATURAL GAS

Thermocatalytic decomposition of methane yields CO_2-free hydrogen and high-value carbon coproducts for transportation and manufacturing industries

To cut its greenhouse gas emissions to 40 percent below 1990 levels, California seeks to put five million zero-emission vehicles on the state's roads by 2030. Many of these vehicles will obtain power from onboard battery-electric systems, but a significant fraction will utilize hydrogen fuel cells.

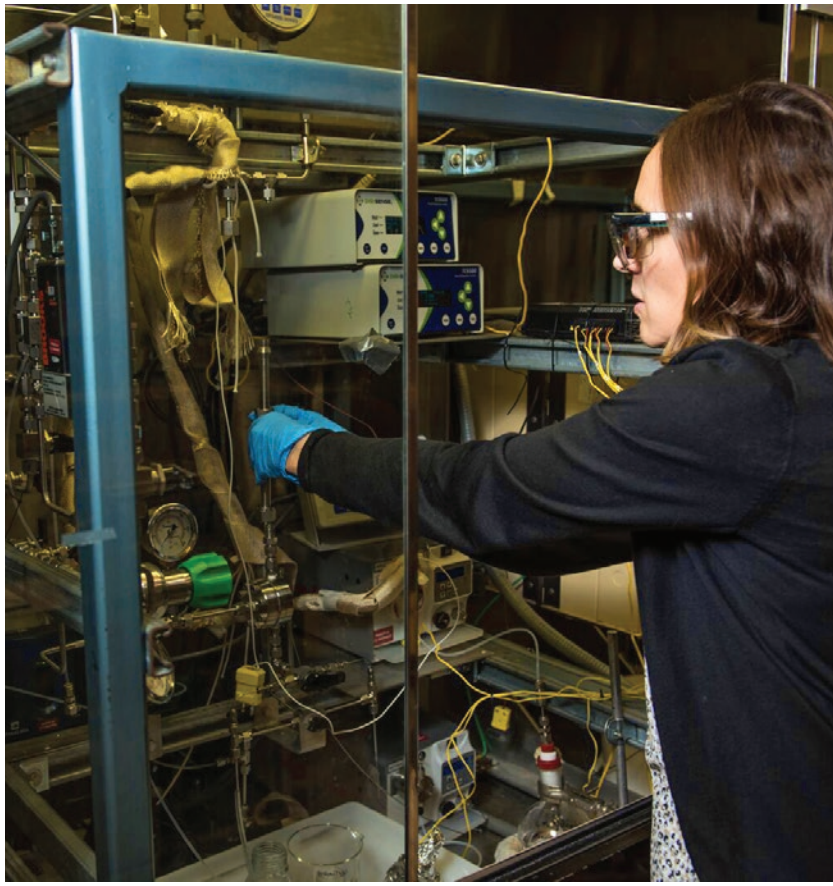
Both methods of powering zero-emission vehicles have their challenges. For hydrogen fuel cell vehicles, one of the biggest hurdles is obtaining a supply of hydrogen. One common source is methane (CH4), the primary constituent of natural gas. Methane is both inexpensive and readily available.

Unfortunately, conventional methods of producing hydrogen from methane, such as steam methane reforming (SMR), come at a steep environmental cost, emitting roughly 11 g of carbon dioxide (CO_2) for every gram of hydrogen produced.

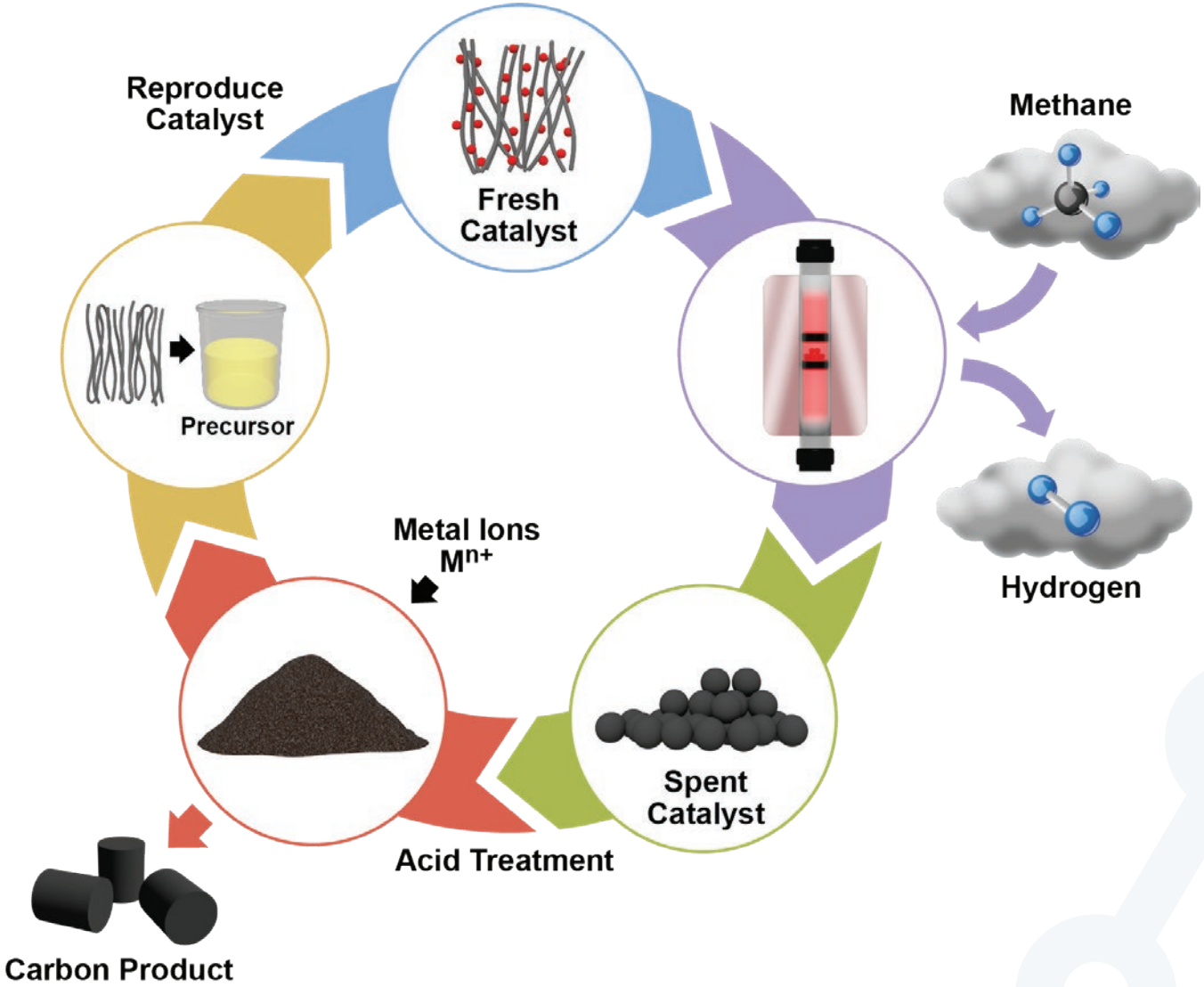
TOTAL PROJECT COST	$3,200,000
SOCALGAS	$700,000
COFUNDING	$2,500,000

Methane pyrolysis, the non-oxidative thermal decomposition of methane, is an alternative to SMR and can produce CO_2-free hydrogen. However, commercial methane pyrolysis technologies are largely nonexistent. In fact, today, only one pilot-scale plant exists in North America.

To address this critical gap, SoCalGas recently cofunded the development of a novel patent-pending methane pyrolysis process for producing CO_2-free hydrogen while simultaneously producing highly



A research team from PNNL and WVU developed and demonstrated a thermocatalytic decomposition process to convert methane into hydrogen at a bench scale. The process also yields a high-value solid carbon co-product suitable for a variety of manufacturing applications.



The PNNL-WVU thermocatalytic decomposition process uses a novel bimetallic catalyst to produce hydrogen. Solid carbon that accumulates on the catalyst is washed and separated for commercial use, while the metallic precursors are re-synthesized and recycled back into the reactor. The closed-loop cycle allows for continuous catalyst replacement while emitting zero carbon dioxide emissions.

valuable carbon coproducts. Originally cofunded by the U.S. Department of Energy (DOE) in 2018, the project sought to develop a new thermodynamic catalytic deposition (TCD) process with lower operating temperatures and, therefore, reduced energy consumption.

Importantly, this approach would also enable plant operators to sell the process's valuable carbon fiber and carbon nanotube (CNT) coproducts, further reducing the net cost of hydrogen production. Carbon nanotubes and carbon fibers have desirable mechanical and chemical properties and can be used in a variety of manufacturing applications ranging from electronics and medical devices to composites for aerospace structures and building systems.

This approach has several advantages over other methane pyrolysis technologies, which typically require high operating temperatures and produce a less valuable, non-crystalline solid carbon product. Other research teams exploring TCD were unable to develop an efficient regenerable catalyst or methods to separate the solid carbon coproducts from the catalyst.

To address these challenges, a team from West Virginia University (WVU) and Pacific Northwest National Laboratory (PNNL) first developed a highly efficient bimetallic catalyst—active, stable, and selective toward desirable carbon and hydrogen coproducts—for the TCD reaction. Second, they developed a way to separate the carbon product from the catalyst and

demonstrated that process at the bench scale.

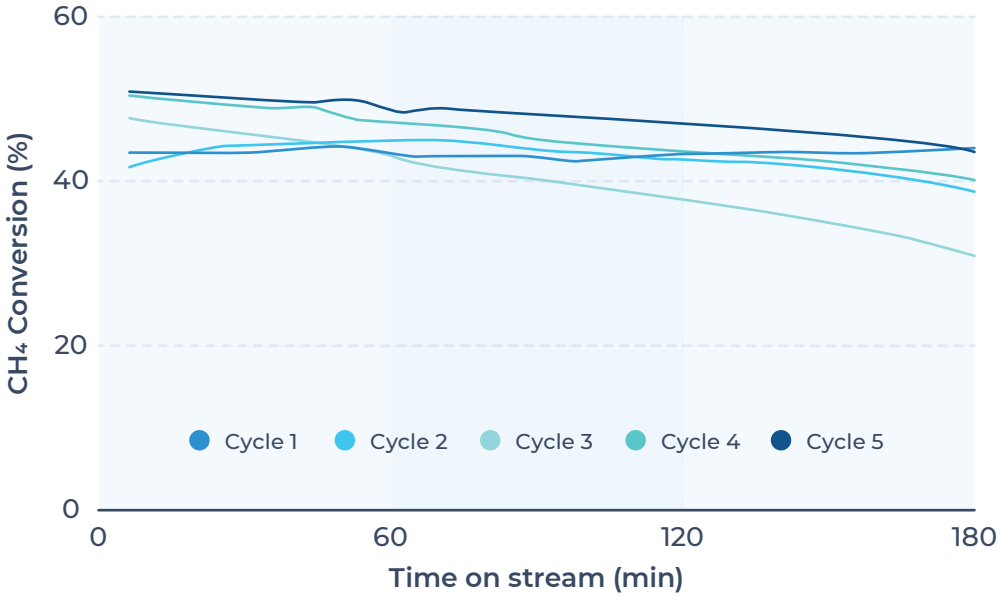
The TCD process starts by flowing methane gas through a patent-pending bimetallic catalyst inside a reactor vessel operating at approximately 600°C. The chemical reaction produces hydrogen as solid carbon accumulates on the catalyst. An acid wash then separates the carbon products from the metallic catalyst precursors, which are then resynthesized using some of the carbon product as catalyst support. The recycled catalyst then re-enters the reactor, completing the loop for continuous catalyst replacement. The high-value carbon coproducts gleaned from the wash process remain separate and available for industrial use.

Using this new method, PNNL techno-economic analyses project a net hydrogen production cost of $2.0/kg at 40,000 – 140,000 tons/year, assuming a solid carbon credit price range between $0.7/kg - $1.2/kg. PNNL also projects a decrease in carbon dioxide emissions of at least 85% compared to conventional SMR for hydrogen production.

Southern California tech startup C4-MCP LLC is participating as a commercialization partner, providing cost-share funding and in-kind resources to identify market opportunities for the solid carbon coproducts. The global CNT market was estimated at approximately $3.5 billion in 2016 and is expected to increase to $8.7 billion by 2022, with robust growth rates of over 17 percent annually. C4-MCP is also identifying additional, new market opportunities made possible with the production of the unique crystalline carbon co-product produced in this process.

The next step in the research proposed to the DOE involves scaling up the TCD process for a pilot-scale demonstration in a fluidized bed reactor. The fluidized bed reactor technology is a key step that enables continuous replacement of the catalyst, as well as the removal of solid carbon co-product. During this second phase, PNNL and WVU will advance the fluidized bed technology by evaluating higher operating temperatures (>650°C) that enable higher-per-pass yields and develop strategies that are increasing catalyst stability.

With successful technology scaleup and envisioned cost offsets from sales of carbon coproducts, the new methane TCD process provides a pathway for fuel cell-powered vehicles to close the cost gap with conventional gasoline and diesel vehicles and pave the way for carbon-free, fuel cell-based microgrid systems that move California closer to its ambitious emissions reduction goals.



Through five cycles of the TCD process, with each cycle lasting three hours, the bimetallic catalyst sustained reactivity and selectivity for producing both CO_2-free hydrogen and high-value solid carbon coproducts.

GAS OPERATIONS

The Gas Operations RD&D program supports pipeline transportation and storage operations through innovations that enhance pipeline and employee safety, maintain system reliability, increase operational efficiency, and minimize GHG impacts to the environment.

The program also supports technology development driven by emerging regulatory requirements. Its primary goals are to develop, test, and introduce new gas operations technologies that are beneficial to ratepayers through improvements in public and pipeline safety, system reliability, operational efficiency, and environmental benefits

The program invests in technology development projects that are divided into the following subprograms:

Environmental & Safety

This subprogram seeks to advance the environmental integrity of the pipeline network and the safety of those who live and work in proximity to it. Environmental projects focus on developing technologies that also support state goals. Safety projects are concerned with protecting the pipeline from intentional and unintentional damage and with improving the safety of the general public and company employees or contractors working on or around the pipeline. Projects include exploring how blending hydrogen into the pipeline impacts the operation and maintenance of the pipeline system regarding safety, reliability, integrity, and environmental impacts.

Further gas emissions monitoring and reduction research is being supported by the SoCalGas Natural Gas Leakage Abatement R&D Program under the SB 1371 compliance plan, pursuant to the Gas Leak Abatement OIR (R.15-01-008).

Operations Technology

This subprogram supports technologies that improve employee training; efficiency of construction; and operation/maintenance/rehabilitation of gas pipelines, as well as systems that facilitate continued safe and reliable service. This subprogram also explores how best to prevent gas leaks that result from blending hydrogen into the pipeline.

System Design & Materials

The objectives of this subprogram are to advance materials and materials science, materials tracking and traceability, and technical tools for designing pipeline systems and infrastructure for safety, reliability, efficiency, and maintainability throughout the lifecycle of pipeline assets. Projects include research to advance engineering design standards and models, developing risk analytical tools to comply with pipeline integrity regulations, modeling operational efficiencies of gas storage and compressor station assets, and assessing the effects of incorporating gas from non-traditional sources (biogas and hydrogen-blend) on overall natural gas quality and system integrity.

System Inspection & Monitoring

The objectives for this subprogram include developing technologies and methods for inspection, monitoring, and testing of pipelines and pipeline components to assess the condition and performance of pipeline facilities. The goal is to improve system performance, reliability, safety and operational efficiencies through data management to identify precursors to failures or incidents. Projects in this subprogram area leverage artificial intelligence, machine learning, and preventive and predictive maintenance technologies, including data analytic models and data lakes, and includes innovative data sources such as Crowd Source and the Internet of Things. This subprogram also seeks to explore tools for managing the potential impacts of blending hydrogen into the gas pipeline.

Gas Operations
SPOTLIGHT

SOCALGAS IDEA LEADS TO ADOPTION OF NEW EMISSION TESTING METHODS

Industry collaboration and funding resulted in U.S. Environmental Protection Agency posting of simplified test methods that reduce environmental compliance costs.

The U.S. National Ambient Air Quality Standards require that the U.S. Environmental Protection Agency (EPA) and state and local agencies regulate the exhaust emissions of criteria pollutants, including nitric oxide (NO), nitrogen dioxide (NO2), and carbon monoxide (CO). Within the gas industry, natural gas boilers and the compressor engines used to maintain pressure and flowrates in gas transmission lines are a source of such emissions.

To verify compliance with the emission limits, facilities conduct expensive and complicated tests using EPA Reference Methods with analyzers in a large trailer or truck. However, plant and facility operators also rely on portable, handheld, electrochemical analyzers to verify compliance using EPA-approved testing methods, as well as to perform operational diagnostics and engine tuning.

TOTAL PROJECT COST	$301,916
SOCALGAS	$36,806
COFUNDING	$265,110

Although highly effective, the EPA-approved test methods for portable analyzers were complex and time consuming, which added significant cost to the compliance process. Developed many decades ago, the test methods did not take advantage of technology advancements that could be used to simplify the method. They were also optimized for much higher emissions targets—hundreds of parts per million (ppmv)—instead of today's much lower numbers, which can require exhaust emission concentrations of less than 20 ppmv.

Research published in 2012 by Gregg Arney and Firas Hamze of

To verify compliance with emission limits, plant and facility operators conduct expensive and complicated tests using EPA Reference Methods with analyzers in a large trailer or truck or handheld, electrochemical analyzers.

HOW IT HAPPENED

SoCalGas confirmed that it was possible to simplify test methods for the portable electrochemical analyzers for emissions at low levels. If implemented, such changes could result in significant cost reductions for utility companies and, by extension, their ratepayers.

To develop a practical, simplified and cost-effective test method, SoCalGas turned to the Pipeline Research Council International (PRCI), a community of the world's leading pipeline companies, vendors, service providers, equipment manufacturers, and other organizations supporting the gas industry. To support this important work, the RD&D Program committed $50,000 toward the $300,000 project across all phases.

Between 2014 and 2020, the PRCI's Compressor Group worked closely with SoCalGas and other utilities, Innovative Environmental Solutions (IES), and various instrument manufacturers to develop the new testing methods. This collaboration resulted in the development of a rigorous technical whitepaper, comprehensive laboratory and field testing at SoCalGas' Pico Rivera and Whittier bases, and field testing at a Dominion Energy gas compressor station near Pittsburgh, Pennsylvania. In 2017, the project team presented its results at the Air Quality Measurement Methods and Technology Conference in Long Beach, California—a presentation that caught the attention of the EPA.

PRCI, SoCalGas, IES, and the industrial instrument manufacturers then began a multi-year process of seeking formal EPA approval for two new testing methods. Conducting extreme due diligence, EPA staff scrutinized every line of the proposed methods, looking for loopholes that might enable a non-compliant compressor, boiler, or other gas-fired equipment to mistakenly pass required compliance or period testing.

In August 2020, after three years of deliberation and review, the EPA formally posted two new test methods, OTM-38 and OTM-39, and approved their use as alternatives to ASTM International methods. These two methods minimize the costs associated with performance testing, while ensuring equivalent or improved data quality compared to the existing method. For example, the new methods reduced the number of gas calibration cylinders required for a typical test setup from 12 to four.

Support from utilities and industry for the new EPA testing methods is resounding. "It's been common knowledge for decades that new electrochemical testing protocols were needed," said Craig McKim, Business Unit Manager, Energy Division, of Testo North America, a prominent portable analyzer manufacturer. "The EPA's new testing protocol is shaking up the compliance testing world by saving testers time and money."

Gas Operations
SPOTLIGHT

DRONES INSPECT DIFFICULT-TO-ACCESS GAS FACILITIES, PIPELINES, AND METERS

Small Unmanned Aerial System (sUAS) and aerial photography provide safer and more efficient access to remote or difficult-to-access gas facilities.

Every year, SoCalGas delivers approximately 1 trillion cubic feet of natural gas to 22 million residential, industrial, and commercial customers across a service territory encompassing more than 20,000 square miles. To deliver such vast quantities of gas—5% of total U.S. gas deliveries—SoCalGas maintains a network that includes roughly six million gas meters, 3,385 miles of transmission pipeline, and 103,477 miles of distribution mains and service lines.

To maintain the safety, integrity, and reliability of this network, SoCalGas inspects each meter and every inch of pipeline. This is a monumental task, especially using conventional approaches such as foot patrols or vehicle-based surveys, which often require visiting facilities that are difficult to access.

In response to this challenge—as well as the requirements of California's SB 1371, which mandated the adoption of procedures to reduce methane emissions from pipeline facilities—the SoCalGas RD&D Program created an Aviation Services Group (AS) in 2015.

TOTAL PROJECT COST	$440,248
SOCALGAS	$440,248
COFUNDING	$0

AS sought to advance the development of a small Unmanned Aerial System (sUAS) for use in the inspection of gas facilities, meters, and pipelines that are remote or difficult to access. When AS first began work, the technology platform as a whole was immature, with numerous technology challenges, including a chaotic wiring system that at times could facilitate miswiring. "At best, the unit failed to function," said tech-

The SoCalGas Aviation Services Group operates small Unmanned Aerial Systems for use in the inspection of gas facilities, meters, and pipelines that are remote or difficult to access.

Aviation Services used the sUAS to conduct a virtual "job walk" along Line 1008A, a pipeline with many hidden and hazardous spans.

nician Mike Watkins. "At worst, there was the potential for damage to a component from making incorrect connections."

During the project, AS evaluated the aerial platform, identified key challenges, and solved numerous payload functionality, system interaction, and application-specific problems. AS tested the sUAS at various SoCalGas operating facilities and in the field, demonstrating aerial photography, videography, and aerial methane detection in the SoCalGas service territory.

After initial success with demonstrations using the Avyon Microdrone MD4-1000, AS began work on the DJI Matrice 210 RT quadcopter in 2018. With a maximum allowable payload of just over five pounds, the DJI Matrice 210 RT is equipped with a Zenmuse Z30 versatile integrated HD camera and gimbal for aerial photography and video. It has a maximum flight time of approximately 17 minutes.

AS assessed the obstacle sensing capability of the DJI Matrice 210 RT during inspections of difficult-to-access residential Meter Set Assemblies. Under overcast skies, the sUAS was able to take images that clearly showed metallic debris that could compromise the electrical isolation of the natural gas piping system. Each image was tagged with date, time, and location stamps.

AS also tested the quadcopter in the inspection of a supply line in the dimly lit environment under a steel-reinforced concrete bridge spanning the Los Angeles River. Any loss of the GPS signal under the bridge could have resulted in loss of the sUAS. AS carefully managed the signal and maintained control of the aerial platform through constant monitoring of the number of available satellites and their corresponding signal strength. "Doing it that way was a challenge, but it was far easier and more affordable than the conventional alternative of sending in a crew on a cherry picker to capture multiple images," said Watkins.

As a further demonstration of the versatility of the sUAS, AS conducted a virtual "job walk" along SoCalGas' Line 1008A, a gas pipeline east of Morro Bay. "This line covers a large area with many hidden and hazardous spans," said Watkins. AS wanted to record high-quality video coupled with still photographs, but the onboard Z30 HD camera was temporarily unable to concurrently capture video and stills.

To resolve this challenge, AS surveyed each location twice, with the second flight utilizing a dedicated Zenmuse X4S still photography camera. Utilizing approved AS contractors, the massive video file was edited to enable the addition of span markers to the video and the extraction of still photography close-ups. "Those capabilities are extremely useful to bidding contractors and the SoCalGas operations team," concluded Watkins.

With this project, the RD&D Program advanced the development of practical unmanned aerial monitoring technology for use in both compliance and emergency inspection of difficult-to-access gas infrastructure. The new systems provide a safer and more efficient method of access to remote or dangerous locations, and also produce a time-and-location-stamped digital image that becomes part of a facility's permanent maintenance record.

CLEAN TRANSPORTATION

The Clean Transportation subprogram supports activities that minimize environmental impacts related to the transportation sector through the development of low-carbon fuels, zero- and near-zero-emissions drivetrains, fueling infrastructure, and on-board storage technologies.

This program includes four subprograms:

On-Road

This subprogram targets emissions reductions from medium- and heavy-duty on-road vehicles. The focus is on-road transportation technologies using hydrogen, RNG, and natural gas.

Off-Road

This subprogram targets emissions reductions from off-road vehicles such as rail, ocean-going vessels and commercial harbor craft, and construction and cargo handling equipment, where gaseous fuels can reduce emissions. Subprogram staff have also begun to explore aviation applications, including hydrogen fuel cell aircraft and drones. The subprogram focuses on developing zero- and near-zero emission off-road transportation solutions using hydrogen, RNG, and natural gas.

Refueling Stations

This subprogram targets the development, demonstration, and deployment of technologies and systems that support refueling for alternative fuels, including hydrogen, RNG, and compressed natural gas (CNG)/liquefied natural gas. The subprogram seeks to identify and manage concerns and issues arising from refueling of gaseous fuels—from storage to safety and standardization.

Onboard Storage

This subprogram targets the development, demonstration, and deployment of cost-effective technologies and systems that improve onboard storage for gaseous transportation fuels. Areas of focus include advanced materials, low-pressure systems, and conformable tanks for both CNG and hydrogen. Onboard storage, which requires compressed storage and/or the use of advanced adsorption technologies, is a critical element needed for increased utilization of low-carbon, low-emission gaseous fuels.

Clean Transportation
SPOTLIGHT

ZERO-EMISSIONS FOR CALIFORNIA PORTS

GTI leads development of hydrogen fuel cell yard tractors for reductions in GHG, criteria pollutant, and diesel particulate matter emissions.

TOTAL PROJECT COST	$12,055,413
SOCALGAS	$322,500
COFUNDING	$11,732,913

Ports are a vital part of the United States economy, serving as gateways for moving freight and passengers across the country and around the world. Seaports alone account for more than 23 million jobs and seaport cargo activity accounts for 26% of the United States economy.

Because they rely to a tremendous degree on diesel-powered cargo handling equipment and vehicles, ports are also a massive source of harmful emissions, including criteria pollutants and greenhouse gases (GHG). The single largest source of port-related cargo handling emissions is the diesel yard

The project team configured two diesel-powered Capacity Trailer Jockey Series TJ9000 gliders (above) with with an electric drive powertrain and a hydrogen fuel cell.

Port of Los Angeles

truck—also known as the terminal tractor. These workhorses of the port put in as many as 20 hours per day, lifting and moving heavy cargo trailers, stopping only once daily for refueling.

In 2019, SoCalGas, GTI, ZEN Clean Energy Solutions, and several technology developers and equipment manufacturers began collaborating on the Zero-Emissions for California Ports (ZECAP) project—funded in part by the California Air Resources Board—to develop and demonstrate two zero-emission hydrogen fuel cell yard trucks at port terminals operated by TraPac at the Port of Los Angeles.

"The primary goal is to demonstrate a novel and unique application of fuel cell technology—the yard truck—in port operations," explained Bart Sowa, a Senior Project Manager with GTI. For each unit, the team configured a Capacity Trailer Jockey Series TJ9000 glider with a BAE Systems electric drive powertrain and an FCveloCity®-HD85 fuel cell from Ballard Power Systems, as well as onboard hydrogen storage tanks.

"Finding room for all of that on the base truck, while staying within the wheelbase constraints and keeping the storage vessels accessible was quite a challenge," said Sowa.

"It was also important that the yard trucks could work long hours without refueling and could refuel quickly when required." For refueling, GTI chose to deploy mobile but permanently installed storage tanks, as well as a custom fueling infrastructure designed and built by Hydrogen Technology & Energy Corporation.

SoCalGas provided $300,000 in cofunding and also offered valuable perspective about infrastructure utilization and product commercialization. "The participation of a large utility like SoCalGas shows this is not a science project but a technology on the path to commercialization," said Sowa.

In 2020, the project team completed engineering design on the hydrogen fuel cell yard trucks, overcoming key constraints related to vehicle wheelbase constraints and storage vessel accessibility. The team also finished engineering design for the custom fueling infrastructure, applied for the permits necessary to install the hydrogen storage tanks and dispenser, and procured all long-lead vehicle components. Assembly of the yard trucks began in late 2020.

Despite some COVID-related delays to the manufacturing and delivery of the onboard storage tanks, deliv-

ery of the two zero-emission yard trucks is scheduled for late April 2021.

Prior to delivery, Frontier Energy will conduct surveys of TraPac operations staff to better understand attitudes toward the new technology. “Equipment operators and maintenance personnel are often apprehensive about trying out new technologies,” said Sowa.

Demonstration of the two zero-emission yard trucks is scheduled for 12 months. Frontier Energy will conduct post-demonstration surveys to assess end user experiences with vehicles. “We believe they will appreciate being able to work without all of the noise, vibration, and odor associated with diesel,” said Sowa.

Successful project completion will result in many benefits and advance hydrogen fuel cell yard truck technology toward commercialization. “If all goes as expected, immediate benefits will include improved operator satisfaction, a quieter and cleaner port environment, and reduced emissions of GHGs, criteria pollutants, and diesel particulate matter,” said Sowa. Importantly, the areas surrounding the Port—many of which are disadvantaged communities—will also experience these benefits.

Further, the project will help fleets around the state better understand how hydrogen fuel cell yard trucks could fit into their business operations. “It will give Capacity and BAE Systems the real-world experience they need to see what works and what doesn’t in this first iteration of a hydrogen fuel cell yard truck,” said Sowa. “So far, everything has been based on engineering simulations.”

“Yard trucks in a port environment have very difficult duty cycles,” said Ted Barnes, Director of R&D at GTI. “In this project, we anticipate being able to prove out the reliability and maintainability of zero-emissions yard trucks in day-to-day port operations. Getting that information is a critical next step in the commercialization of these vehicles.”

“Having SoCalGas on the team has been very valuable,” continued Barnes. “Their involvement shows terminal operators, truck manufacturers, and technology developers that a major gas utility believes that hydrogen fuel cell technology has a place in our nation’s demanding port environments.”

ZECAP is part of California Climate Investments, a statewide initiative that puts billions of Cap-and-Trade dollars to work reducing greenhouse gas emissions, strengthening the economy, and improving public health and the environment—particularly in disadvantaged communities. www.calclimateinvestments.ca.gov

CLEAN GENERATION

This program targets the development and demonstration of high-efficiency products and technologies associated with the generation of power for the residential, commercial, and industrial market segments in order to reduce emissions, lower customer costs, integrate renewable fuels, and improve energy reliability and resiliency.

Clean Generation is composed of two subprograms:

Distributed Generation

This subprogram develops and enhances distributed generation technologies. Microgrids and the increasing availability of RNG and hydrogen offer new opportunities for the deployment of low-emission and renewably fueled distributed generation technologies.

Integration & Controls

This subprogram develops, enhances, and demonstrates technologies and control systems that integrate distributed generation resources and thermal loads. The focus is on enabling low-emissions, distributed generation, and storage technologies to provide energy resilience and affordability to customers.

Clean Generation
SPOTLIGHT

BREAKTHROUGH AC SYSTEM REDUCES ELECTRICITY CONSUMPTION BY 60–80%

Florida technology company integrates revolutionary air conditioning system with fuel cells for massive energy savings and reduced cost.

Modern air conditioning (AC) provides comfort and drives productivity and commerce. Unfortunately, it comes at a high cost, producing GHG emissions and utilizing harmful refrigerants. To address this cost, Blue Frontier is developing an innovative AC system that will eliminate some of the most harmful side effects of conventional AC, while keeping buildings more comfortable.

The company's first product is a drop-in replacement for the rooftop AC units found on 97% of all commercial buildings under four stories. Currently under development, it's designed to provide 30% fresh air, offer independent control of humidity and temperature, and reduce energy consumption by 60 to 80% when compared to today's best available technology.

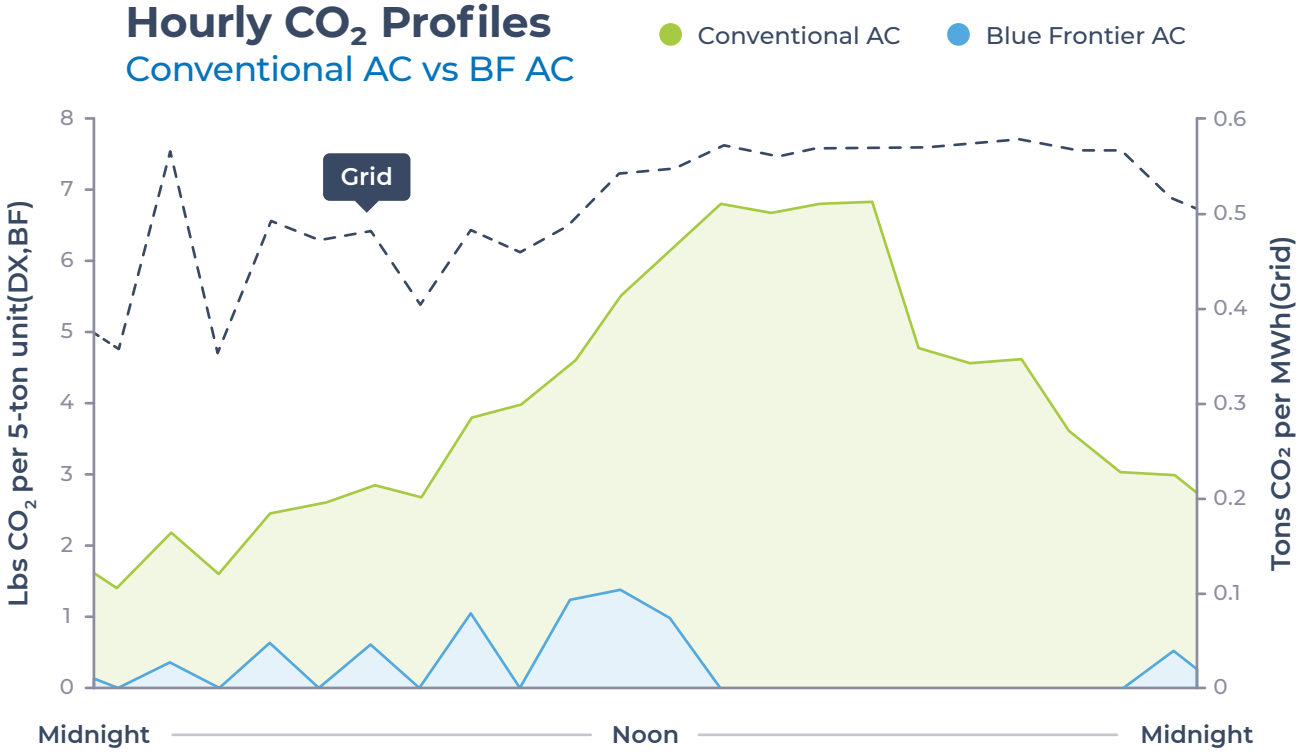
TOTAL PROJECT COST	$540,000
SOCALGAS	$540,000
COFUNDING	$0

Blue Frontier designed the system to incorporate heat recovered from gas-fueled combined heat and power (CHP) units—including fuel cells—via a load-shifting thermochemical energy-storage system that uses a liquid desiccant to store energy. When recovered heat is readily available, the system stores this energy by increasing the concentration of the liquid desiccant.

The opportunity for integration with fuel cells caught the eye of staff at the SoCalGas RD&D Program.

"They saw the potential our technology has to work with fuel cell systems using hydrogen or natural gas

The innovative A/C system incorporates heat recovered from gas-fueled CHP units—including fuel cells—via a load-shifting thermochemical energy-storage system that uses a liquid desiccant to store energy.



Blue Frontier reductions in carbon dioxide emissions compared to those from a conventional AC system.

to generate electricity and produce waste heat," said Dr. Daniel Betts, CEO of Blue Frontier. "Traditionally, buildings use the heat from CHPs to heat water or building spaces. Our system can use this heat to regenerate the liquid desiccant, displacing more costly grid-sourced electricity and delivering low-cost air conditioning when electricity rates are at their highest."

To advance this technology, Blue Frontier collaborated with SoCalGas, Energy and Environmental Economics, and the National Renewable Energy Laboratory on a multi-phase project.

In phase one, they established the value proposition for the product by developing baseline models and exploring energy cost savings across various building types and locations throughout California. SoCalGas offered perspective on fuel cells, technology rollouts, and the target market and customers.

Initial models indicated a high likelihood of commercial success. Using grid-sourced electricity to recharge the liquid desiccant, the models showed the potential to reduce air conditioning energy consumption by an average of 81%, resulting in carbon dioxide emissions reductions averaging 12% in residential buildings and 15% in commercial buildings. System performance further improved when the models assumed utilization of waste heat from a fuel cell to regenerate the liquid desiccant, offsetting cooling-related electrical consumption. "That effectively increases the electrical efficiency of the fuel cell and improves its economics," said Dr. Betts.

Phase two is underway, with testing scheduled for April to June 2021. "We are completing assembly of the first prototypes and plan to

evaluate their performance in multiple simulated climate conditions," said Dr. Betts. "Ultimately, we hope to validate the phase-one models and identify ways to improve performance and design."

By helping eliminate peak demand on the grid, this technology could reduce ratepayer costs. "We could actually eliminate or significantly reduce the need for battery storage, peaking plants, and transmission and capacity upgrades," said Dr. Betts. "Take away the need for grid-sourced electricity and transfer it to the natural gas supply in a super-efficient way and it actually creates dramatic reductions in carbon dioxide compared to any other piece of equipment you could buy."

By reducing peak demand, the technology delivers another benefit. "One of the main causes of forest fires is the sagging of power lines during peak demand, which is largely driven by the demand for air conditioning," said Dr. Betts. "By eliminating this demand, this technology could reduce the risk of fires and provide reliable electricity and air conditioning service when it's needed most."

Blue Frontier anticipates pursuing customers in the commercial building market first. "U.S. commercial building owners buy roughly 300,000 rooftop units every year—it's a robust and large market, with millions of units nationwide nearing the end of their useful lifetimes," said Dr. Betts. Ultimately, Blue Frontier seeks to deploy 1,000 units by 2024 as a first phase of product commercialization.

Following this project, Blue Frontier plans to conduct dynamic testing at the UC Davis Western Cooling Efficiency Center through the CalTestBed program. "That will enable us to finalize unit controls, demonstrate it in actual field trials, and deploy it in a statistically significant field trial," said Dr. Betts. "With that completed, we could ramp up manufacturing quickly and go to market with real accuracy."

The RD&D Program was an essential component of the project's success. "SoCalGas is an extremely innovative gas company seeking to solve some of California's most significant obstacles on the path to reducing GHG emissions," said Dr. Betts. "They helped convene the right team and made sure that the project met appropriate levels of engineering rigor before financing its development with a clear, strategic path. California is lucky to have a company like SoCalGas."

Blue Frontier anticipates pursuing customers in the U.S. commercial building market first, which purchases roughly 300,000 rooftop units per year. In the near term, Blue Frontier seeks to deploy 1,000 units by 2024 as a first phase of product commercialization.

CUSTOMER END-USE APPLICATIONS

This program focuses on developing, demonstrating, and commercializing technologies that cost-effectively improve the efficiency and reduce the environmental impacts of gas equipment used in residential, commercial, and industrial settings

This program includes five subprograms:

Commercial Food Service

This subprogram develops and enhances technologies and advancements related to commercial food service. This includes restaurants, catering services, and institutional kitchens that primarily rely on fuel supplied by SoCalGas for cooking and water heating. In response to the COVID-19 pandemic, this subprogram may also explore new solutions, such as adapting to increased outdoor dining.

Residential Appliances

This subprogram develops, demonstrates, and enhances technologies and advancements related to gas-consuming appliances in residences. Subprogram staff also seek to adapt proven European technologies to the California market. Relevant appliances include furnaces, hot water heaters, stoves, ovens, and dryers.

Commercial Applications

This subprogram develops and enhances technologies and advancements related to gas consumption and end-uses in the commercial sector. Relevant applications include commercial HVAC, hot water service, and commercial laundry.

Industrial Process Heat

This subprogram develops advanced heating technologies and systems for use in the industrial sector. Relevant applications include food processing, textile drying, chemical processing, and other process heat needs.

Advanced Innovation

This new subprogram seeks to develop new technologies to increase energy efficiency and decrease emissions.

Customer End-Use Apps
SPOTLIGHT

INNOVATIVE RESIDENTIAL WATER HEATER MOVES TOWARD COMMERCIALIZATION

Gas-fired heat pump saves energy, cuts homeowner costs, and reduces GHG emissions by 49%.

Water heating accounts for 7% of residential carbon dioxide emissions. A new generation of gas-fired water heaters that utilize a heat pump to capture ambient heat and preheat the water could substantially reduce those emissions and achieve greater than 100% energy efficiency.

With its aggressive decarbonization goals and widespread deployment of conventional residential gas-fired water heaters, California is an ideal market for such a technology. Recognizing this opportunity, GTI—one of the nation's leading gas R&D firms—collaborated with SoCalGas and other industry stakeholders on a project funded by the California Energy Commission (CEC), Stone Mountain Technologies, Inc. (SMTI), and the Utilization Technology Development consortium.

TOTAL PROJECT COST	$1,272,355
SOCALGAS	$188,125
COFUNDING	$1,084,230

"Our primary goal was to field-test 4th-generation gas-fired heat pump water heater prototypes in five single-family homes in the Los Angeles basin," said Merry Sweeney, senior market analyst at GTI. The team also conducted market research to better understand the path to commercialization.

SoCalGas believes this technology has the potential to deliver significant energy savings to its ratepayers. To support the project, SoCalGas performed simulated extended life and performance testing on the prototype. "They also helped us secure the five residential demonstration sites," said Sweeney.

GTI field-tested 4th-generation gas-fired heat pump water heater prototypes in five single-family homes in the Los Angeles basin.

The project kicked off in 2017 with the placement of five hand-tooled, precommercial prototypes in homes in the Los Angeles basin. Building on work begun in 2011 with SMTI, the prototype was designed as a drop-in replacement for conventional gas-fired water heaters, requiring only minor building modifications.

The idea behind the technology is simple. "The gas-fired heat pump draws heat from the ambient space and uses it to pre-heat the water in the tank," said Sweeney. Less gas is required to heat the water to the set-point temperature. "You actually get more energy—hot water—out of the system than you put in because of the boost provided by the ambient heat."

During 12 months of field and lab testing, GTI faced several challenges, including minor mechanical failures and a lack of installation guidelines addressing venting, electrical service, and space requirements. "We addressed these challenges and also identified two critical challenges to explore—how to design the units for safe, damage-free shipment and how to address high-draw events that can drain the tank faster than it can heat new water."

Upon project completion, GTI believed it had demonstrated a product ready for the market, and also proved there was a market for the product. "We demonstrated very strong energy, cost, and emissions savings, and clearly established the technical viability of the product," said Sweeney. "The homeowners and installation contractors were also very satisfied with it."

Gas-fired heat pumps represent a huge opportunity. "In comparison to conventional water heaters, this technology can reduce GHG emissions by roughly 49%," said Sweeney. "When deployed widely, it represents a real opportunity for gas to play a key role in building decarbonization."

GTI and SoCalGas plan to use this project as a springboard to a larger, bi-national demonstration effort through the North American Gas Heat Pump Water Heater Demonstration Collaborative. "We will perform field, lab, and market evaluations of next-generation gas-fired heat pump water heaters manufactured by Rinnai, a global manufacturer," said Sweeney. The project plans to deploy 55+ near-commercial units across the United States and Canada, including 15 within SoCalGas territory.

The potential benefits are significant. "For each gas-fired heat pump water heater installed, we saw a reduction in GHG emissions of approximately 2,200 lbs. per year," said Sweeney. "If this technology could achieve 10% market penetration in California, we'd be looking at annual emissions reductions of roughly half a million metric tons."

Appendix

2020 FUNDING RECIPIENTS

3V Geomatics

Aggregate Strategies LLC

Airgas USA LLC

Allen Instruments & Supplies

Alliance for Sustainable Energy LLC

ALS Environmental

Alta Foodcraft Coffee Services

American Institute of Chemical Eng

Battelle Memorial Institute

Blue Frontier LLC

California Institute of Technology

CALSTART

C. H. Robinson Company

Cherokee Nation Office Solutions

Connection

Czero LLC

DNV GL USA Inc

Douglas G Honegger

Dragonfly Vision

Eclipse Mapping and GIS LLC

Energy Solutions Center

Eurofins Calscience Inc

Fiedler Group

Fluor Enterprises Inc

Gas Machinery Research Council

Gas Technology Institute

Geodetics Inc

Getty Images Inc

Gladstein Neandross & Associates

Hyet Hydrogen USA LLC

Innovative Environmental

Integral Engineering Consulting

Jacobs Engineering Group Inc

Jay's Catering

Kevala Inc

Lantec Products Inc

Lawrence Berkeley National Lab

Lawrence Livermore National Laboratory

Linde Engineering North America LLC

Lotus Consulting

Martys Hobbies

Mcmaster Carr Supply Co

Michael Naylor, Consultant

Netcentric Technologies Inc

Noble Thermodynamic Systems Inc

Northeast Gas Association

NV5 Inc

Operations Technology Development

Opus 12 Inc

Pacific Petroleum California Inc

Parsons Environment & Infrastructure

Pergam Technical Services Inc

Pipeline Research Council Intl Inc

Primary Gas Solutions

R. R. Donnelley

Reactwell LLC

Resource Innovations LLC

RICOH USA Inc

Rinnai America Corporation

Royal Industrial Solutions

Sandia National Laboratories

Scaled Power Incorporated

South Coast Air Quality Management District

STAPLES Contract & Commercial LLC

Stars Technology Corporation

The Board of Trustees of The Leland Stanford Junior University

The Carlab Inc

The Grant Farm

The Sourcium Group

Susteon Inc

Tri Tool Inc

US Hybrid Corporation

UC Regents - University of California Irvine

UC Regents - University of California Davis

UC Regents - University of California Riverside

Xebec Adsorption Inc

Zuber Lawler & Del Duca LLP

2020 PUBLICATIONS, REPORTS, AND PATENTS

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2020 GOVERNMENT AGENCY FUNDING AWARDS

Lead Investigator	Research Program	RD&D Funding Committed	Funding Awarded	Agency
Susteon, Inc	LCR	75,000	999,722	DOE
GTI	CEUA	150,000	1,424,704	CEC
GTI	CT	350,000	2,599,733	DOE
Cummins Inc	CT	240,000	3,443,663	DOE
West Virginia University	CT	150,000	1,085,682	DOE
University of California Irvine	CEUA	550,000	4,000,000	DOE
Opus 12	LCR	500,000	2,500,000	DOE BETO
Climeworks	LCR	300,000	2,500,000	DOE
IWVC, LLC	LCR	650,000	2,500,000	DOE/FE
Susteon/University of Wyoming	LCR	100,000	799,687	DOE/FE
Caltech	LCR	0	850,000	ARPA-E
Missouri University of Science and Technology	CT	0	550,000	NSF
University of California Irvine	CG	50,000	200,000	DOE
Noble Thermodynamic Systems, Inc.	CG	500,000	3,842,312	DOE
NREL	CT	80,000	422,000	DOE
GTI	CT	500,000	3,999,971	CEC
Golden Gate Zero Emissions Marine	CT	200,000	2,000,000	CEC
CALSTART	CT	100,000	498,309	CEC
Shell	CT	500,000	4,000,000	CEC
TOTAL		**$4,995,000**	**$38,215,783**	

POLICY DRIVERS

Category	Regulations & Policy Drivers
GHG Emissions	**SB 32:** Reduce CO2 emissions 40% below 1990 levels by 2030 **SB 100:** Zero-carbon electricity by 2045 **EO B-55-18:** Carbon-neutral California economy by 2045 **AB 3232:** Building decarbonization
Pipeline Safety	**CPUC General Order 112F:** Rules governing design, testing, operation, and maintenance of gas transmission and distribution systems **DOT 49 CFR Part 192:** Federal pipeline safety regulations **AB 1900:** Biomethane quality standards **OIR R.13-02-008, Phase 4:** Addresses injection of renewable hydrogen into gas pipelines
Local Air Quality	**Clean Air Act:** Air quality standards for NOx and PM **AB 617:** Pilot communities for air quality improvements

PUBLIC UTILITIES CODE (PUC) 740.1.

The commission shall consider the following guidelines in evaluating the research, development, and demonstration programs proposed by electrical and gas corporations:

(a) Projects should offer a reasonable probability of providing benefits to ratepayers.

(b) Expenditures on projects which have a low probability for success should be minimized.

(c) Projects should be consistent with the corporation's resource plan.

(d) Projects should not unnecessarily duplicate research currently, previously, or imminently undertaken by other electrical or gas corporations or research organizations.

(e) Each project should also support one or more of the following objectives:

(1) Environmental improvement.

(2) Public and employee safety.

(3) Conservation by efficient resource use or by reducing or shifting system load.

(4) Development of new resources and processes, particularly renewable resources and processes which further supply technologies.

(5) Improve operating efficiency and reliability or otherwise reduce operating costs.

Methane Emissions	**SB 1383:** Reduce methane emissions from decomposition of organic wastes **CARB Oil and Gas Rules:** Requires new monitoring and repairs to reduce methane emissions **Natural Gas STAR Program:** Encourages adoption of methane-reducing technologies and practices **EPA Methane Challenge Program:** Recognizes oil and gas companies that take comprehensive action to reduce methane emissions
Clean Transportation	**ARB Implementation Plan:** Low-NOx standard for trucks **AB 8:** Development of 100 hydrogen fueling stations in California **EO-B32-15:** Sustainable freight action plan **EO-B48-18:** 200 hydrogen refueling stations by 2025 **EO N-79-20:** 100% of medium- and heavy-duty vehicle be zero emission by 2045 for all operations where feasible **LCFS:** Reduce carbon intensity of fuels by 10% by 2020 **SB 1275:** One million zero-emission and near-zero-emission vehicles by 2023
Equity	**CPUC General Order 156:** Encourages IOUs to procure or contract goods and services from women, minority, disabled veteran and/or LGBT owned business enterprises **CPUC ESJ Action Plan:** Increases investment in clean energy resources to benefit environmental and social justice communities, especially to improve local air quality and public health

RESEARCH CONSORTIA

Northeast Gas Association (NGA)/NYSEARCH[1]

NYSEARCH manages one of the premier natural gas RD&D programs in North America. NYSEARCH is a collaborative RD&D organization dedicated to serving its 20 gas utility member companies and project funding partners. NYSEARCH members voluntarily participate in projects and programs to target RD&D areas that address their unique challenges and opportunities. For more than 20 years, NYSEARCH has worked as a consortium of natural gas LDCs that have common interests and needs, such as continually improving the operation, safety, efficiency, maintenance and upgrade of gas delivery systems.

Today, as part of the NGA, NYSEARCH manages more than 30 projects in various stages of development. NYSEARCH has grown steadily in recent years because of its success in delivering high-value RD&D projects. The organization is unique in its ability to help member companies & partners leverage RD&D investments, while targeting their participation to projects that best meet their individual needs. The core of the NYSEARCH model is joint collaboration and guidance from participating members. These members participate in a wide variety of RD&D projects, organized under the following categories:

- Pipeline Integrity/Direct & Remote Assessment
- Pipe Location & Damage Prevention
- Leak Detection, Real-time Sensing & Inspection for Distribution
- Environment/Reducing Greenhouse Gas Emissions
- Gas Quality
- Evaluation of New Materials
- Advanced Polyethylene Piping and Joining
- Oracle (emerging technologies from other industries)

Total 2020 Projects
16

Initiated
5

Completed
0

2020 Subscription Fee
$60,000

2020 SoCalGas RD&D Project Funding
$287,801

1 https://www.nysearch.org/index.php

SoCalGas is cofunding NGA/NYSEARCH projects in the following areas: enhancing robotic inline inspection systems, pipeline crack sensors, detection of pipeline odorants, non-destructive evaluation of polyethylene fusion joints, and gas interchangeability. In 2020, three projects reached the milestone of completing a phase of the project and moving to the next phase of research.

Operations Technology Development[2]

OTD is a member-controlled partnership of 26 natural gas distribution companies formed to develop, test, and implement new technologies. The objective of OTD is to address a wide range of technology issues relating to gas operations and its infrastructure. Its projects are designed to:

- Enhance system safety
- Improve operating efficiencies
- Reduce operating costs
- Maintain system reliability and integrity

Since 2003, OTD's collaboration of industry leaders, scientists, technicians, and manufacturers has been charting a course to address integrity issues and other concerns by identifying industry needs and providing focused R&D responses that benefit the natural gas industry and its customers.

By working collaboratively, participating companies leverage funds so no single company is responsible for carrying the entire financial burden. In addition, participants benefit from input from numerous sources, address common regulatory issues, and serve to demonstrate the broad industry support needed to gain the interest of potential product manufacturers.

SoCalGas is cofunding OTD projects in the areas of pipeline inspection and repair, the impact of hydrogen-natural gas blends, pipeline material tracking and traceability, third-party damage prevention, and methane emissions detection/quantification.

OTD
Operations
Technology
Development

Total 2020 Projects
57

Initiated
14

Completed
13

2020 Membership Dues*
$750,000

2020 SoCalGas RD&D Project Funding
$364,672

*Membership dues fund Program Management expenses and are directed to projects selected by SoCalGas RD&D. Dues are calculated based on number of customer meters (OTD, UTD) or miles of transmission pipeline in service (PRCI).

2 https://otd-co.org/Pages/default.aspx

Pipeline Research Council International[3]

PRCI is a community of the world's leading pipeline companies, and the vendors, service providers, equipment manufacturers, and other organizations supporting the industry. Since 1952, PRCI has been recognized around the world as a unique forum within the energy pipeline industry delivering great value to its members and the industry—both quantitative and qualitative—through the development and deployment of research solutions to improve pipeline safety and performance. PRCI's mission is to collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems.

PRCI is dedicated to assuring the maximum efficiency of research, development, and deployment through a highly leveraged funding model of member and external funding, information sharing, cooperative research development, and the broad dissemination and application of its results. Along with funding, the strength of the collaborative model stems from the contributions to PRCI of member technical and operations experts and the ongoing support to them from PRCI and its companies. It is this collaboration in the direction, implementation, and adoption of research that defines PRCI's value to its members and the industry.

PRCI's Value Proposition is to use the leverage generated by its members' resource contributions to create a research forum of ideas and results producing solutions that assure the safe, reliable, environmentally sound, and cost-effective pipeline transportation of energy to consumers worldwide.

SoCalGas is supporting PRCI's technology development focusing on ultrasonic metering performance accuracies, improving welding processes, assessment of weld seam anomalies, airborne and satellite pipeline monitoring, natural gas engine performance improvements, downhole storage well integrity, and improving pipeline construction processes.

Total 2020 Projects

70

Initiated

13

Completed

28

2020 Membership Dues*

$147,774

2020 SoCalGas RD&D Project Funding

$43,503

*Membership dues fund Program Management expenses and are directed to projects selected by SoCalGas RD&D. Dues are calculated based on number of customer meters (OTD, UTD) or miles of transmission pipeline in service (PRCI).

3 https://www.prci.org/

Sustaining Membership Program

The SMP is a collaborative R&D program with two segments, Utilization and Operations. SMP's mission is to build a strong technology base in natural gas operations, energy utilization, environmental science and renewable energy; to create new, innovative solutions through "proof of concept" work that addresses the most important industry needs; and to conduct early-stage R&D that serves as the building blocks of subsequent commercial research efforts. Members collectively leverage experience, expertise, and funds to reduce the risk and uncertainty of R&D to help push clean, safe energy solutions on a path toward future gains. In 2020, the RD&D Program worked on 30 active/continuing SMP projects.

SoCalGas is sponsoring early-stage research in the areas of natural gas operations and environmental science, which entails technology developments in PE static electricity detection, advanced hand tools, removal of hazardous RNG constituents, laser-based QC inspection tools, and small diameter internal pipeline inspection systems.

2020 Completed SMP Projects

- Static Electricity Detection and Characterization Tool – Phase 3
- Data Collection with Laser Technologies
- Captured CO2 Modular System for Renewable Natural Gas Production
- Evaluation of Boost Heat and Climate Well Thermodynamic Cycles for Space and Water Heating
- Metamaterials for Advanced Gas-Fired Equipment
- CNG Storage Cylinder Internal Diffuser Evaluation
- Advanced Modular High-Efficiency Hybrid Heat Engine

The Flame of Innovation
SMP

Total 2020 Projects
46

Initiated
16

Completed
7

2020 Membership Dues*
$100,000

2020 SoCalGas RD&D Project Funding
$95,400

*Membership dues fund Program Management expenses and are directed to projects selected by SoCalGas RD&D. Dues are calculated based on number of customer meters (OTD, UTD) or miles of transmission pipeline in service (PRCI).

New 2020 SMP Projects

- Evaluating the Potential of Algae Capture of CO_2
- Exploring the Feasibility of Deploying Sensor Systems in 2” Pipe
- Assessment of Risk Approaches Used by Other Industries Addressing Human Error
- A Framework for Investigating the Use of Smart Meters in Predicting Leaks and Unaccounted-for
- Gas Losses in the Gas Distribution System [Phase 1]
- Service Tee Saddle Removal Tool
- Non-Marking Pipe Wrench and Tools
- Conformable Insertable Power Turbine for Powering Sensors and Wireless Communications
- Evaluation of portable scanning technology, including mobile devices, for threads inspection
- Variation of leak surface expressions/indications throughout the day
- Uncertainty Quantification of Machine Learning Models
- Hydrogen/RNG-Flexible, High-Efficiency Advanced Burner
- Synthetic Air to Capture and Re-Use Carbon
- Mitigating Methane Emissions from Industrial and Large Commercial End Use Equipment
- Efficient High Temperature Thermoelectric Generators for Self- and Remote-Power
- Embedded Hydrogen Microsensor

Utilization Technology Development[4]

UTD is at the forefront of research, development, and deployment for end-use equipment and appliances. As a not-for-profit corporation led by our 20 utility member companies, UTD represents over 37 million natural gas customer accounts in the Americas. UTD directs and sponsors a wide-ranging program to enhance the use, reliability, and efficiency of appliances and technologies that use natural gas or renewable natural gas to benefit ratepayers, utilities, and the environment.

UTD's mission is to "Identify, select, fund, and oversee research projects resulting in innovative customer solutions which maximize the environmental performance, affordability, efficiency, and safety of equipment and processes that use natural gas and renewable energy resources."

UTD's RD&D technology portfolio impacts residential, commercial, industrial, and transportation market segments, and includes gas equipment and appliances, industrial process and combustion systems, distributed generation, CHP systems, and natural gas vehicles. UTD's member companies work together in a collaborative manner to control and direct program content, initiatives, individual research projects, and other activities. These solutions more effectively:

- Save consumers money
- Save energy
- Enable safe, reliable, and resilient operation of end user's equipment and energy delivery systems
- Achieve superior environmental performance
- Integrate with renewable energy sources

UTD partners closely with federal, state, and local government research funding agencies, as well as manufacturers, universities, research organizations, and other industry stakeholders to ensure effective program results and leverage member investments with significant additional research funding. With its members and partners, UTD has been shaping the energy future with new efficient end-use technologies since 2004.

Total 2020 Projects
100

Initiated
29

Completed
29

2020 Membership Dues*
650,000

2020 SoCalGas RD&D Project Funding**
$714,664

*Membership dues fund Program Management expenses and are directed to projects selected by SoCalGas RD&D. Dues are calculated based on number of customer meters (OTD, UTD) or miles of transmission pipeline in service (PRCI).

**Includes voluntary funding contribution made in 2020 to fund additional research projects.

4 https://www.utd-co.org/Pages/default.aspx

ACRONYMS

Acronym	Definition
% wt.	Percentage by Weight
°C	Degree Celsius
°F	Degree Fahrenheit
A/cm²	Ampere Per Square Centimeter
AC	Alternating Current
AEM	Anion Exchange Membrane
AERMOD	EPA's required tool for estimating impacts from air pollutant emission sources, including natural gas compressor drivers.
AFUE	Annual Fuel Utilization Efficiency
AGA	American Gas Association
AHU	Air Handler Unit
AI	Artificial Intelligence
ALOS	Advanced Land Observing Satellite
AMI	Automated Metering Infrastructure
ANG	Adsorbed Natural Gas
ANGP	Adsorbed Natural Gas Products, Inc.
ANSI	American National Standards Institute
APC	Argon Power Cycle
API	American Petroleum Institute - API is a standards-setting organization for America's oil and natural gas industry.
ARPA-E	Advanced Research Projects Agency-Energy
ART	Acoustic Resonance Technology
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BF	Butt Fusion
BONCAT	Bioorthogonal Noncanonical Amino Acid Tagging
BPM	Bipolar Membrane
BRASH	BRASH Engines, Inc.
Btu/hr	British Thermal Units Per Hour
CA	California
CalSEED	California Sustainable Energy Entrepreneur Development Initiative
Caltech	California Institute of Technology
CARB	California Air Resources Board
CARB-DG	California Air Resources Board Distributed Generation
CCTWH	Central Condensing Tankless Water Heating System
CE-CERT	Bourns College of Engineering, Center for Environmental Research & Technology
CEA	Controlled Environment Agriculture
CEC	California Energy Commission
CEM	Cation Exchange Membrane
CEPM	Comprehensive Equipment Performance Monitoring
CEQA	California Environmental Quality Act
CERC-WET	Clean Energy Research Center, Water & Energy Technology
CFD	Computational Fluid Dynamics
CFM	Cubic Feet per Minute
CFR 49	Title 49 of the Code of Federal Regulations
CFS	Commercial Food Service
CGA	Common Ground Alliance

CH_2O	Formaldehyde
CH_4	Methane
CHG	Catalytic Hydrothermal Gasification
CHP	Combined Heat and Power
CHS	Center for Hydrogen Safety
CI	Compression Ignition
CLSM	Controlled Low-Strength Material
cm^2	Square Centimeter
CMIC	Carbon Management Information Center
CMR	Center for Methane Research
CNG	Compressed Natural Gas
CNTP	Catalytic Non-Thermal Plasma
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CoC	Certificate of Compliance
COP	Coefficient of Performance
COVID-19	Coronavirus Disease 2019
CP	Cathodic Protection
CPUC	California Public Utilities Commission
CRADA	Cooperative Research and Development Agreement
CSA	Compliance, Safety, Accountability
CSULA	California State University Los Angeles
CT	Computed Tomography
CWI	Cummins Westport, Inc.
D-EGR	Dedicated Exhaust Gas Recirculation
DAC	Direct Air Capture
DC	Direct Current
DCP	Dynamic Cone Penetrometer
DER	Distributed Energy Resources
DG	Distributed Generation
DGE	Diesel Gallon Equivalent
DHW	Domestic Hot Water
DIMP	Gas Distribution Integrity Management Program
DMI	Doosan Mobility Innovation
DMS	Dimethyl Sulfide
DOE	U.S. Department of Energy
DOE BETO	U.S. Department of Energy's Bioenergy Technology Office
DOT	U.S. Department of Transportation
DR	Demand Response
DSM	Demand-Side Management
E3	Energy and Environmental Economics
ECDA	External Corrosion Direct Assessment
EEDs	Electricity Emitting Diodes
EERE	Office of Energy Efficiency and Renewable Energy
EGR	Exhaust Gas Recirculation
EHP	Electric Heat Pumps
EHPC	Electrochemical Hydrogen Purification & Compression
EMAT	Electromagnetic Acoustic Transducer
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EPSS	Emergency Power Supply System
ERW	Electric Resistance Welding
ESC	Energy Services Coalition
EV	Electric Vehicle
FCGR	Fatigue Crack Growth Rate
FCHEA	Full Cell & Hydrogen Energy Association
FEA	Finite Element Analysis

FERC	The Federal Energy Regulatory Commission
FEV	Forschungsgesellschaft für Energietechnik und Verbrennungsmotoren
FLECCS	FLExible Carbon Capture and Storage
FPIP	Food Production Investment Program
FPLM	Free Piston Linear Motor
ft	Feet
g	Gram
GAHP	Gas Absorption Heat Pump
GENSETS	Generators for Small Electrical and Thermal Systems
GFEN	Gas Foodservice Equipment Network
GFO	Grant Funding Opportunity
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GHP	Gas Heat Pumps
GHPWH	Gas Heat Pump Water Heater
GIS	Geographic Information System
GmbH	Gesellschaft mit beschränkter Haftung
GMRC	Gas Machinery Research Council
GNA	Gladstein Neandross & Associates
GPS	Global Positioning System
GQDB	Gas Quality Database
GQRC	Gas Quality Resource Center
GQS	Global Quality Services
GTI	Gas Technology Institute
GVHP	Gas Vuilleumier Heat Pump
H_2	Hydrogen
H21	A suite of gas industry projects designed to support conversion of the UK gas networks to carry 100% hydrogen.

H_2S	Hydrogen Sulfide
H_2SO_4	Sulfuric Acid
H3	Hydronic Heating Hub
HAZ	Heat-Affected Zone
HCA	Hierarchical Clustering Analysis
HCDP	Hydrocarbon Dew Point
HCNG	Hydrogen Compressed Natural Gas
HES	Hydrogen Energy Storage
HiGRID	Holistic Grid Resource Integration and Deployment
HOPE	Hispañas Organized for Political Equity
HSD	Hardness, Strength, and Ductility
HTL	Hydrothermal Liquefaction
HVAC	Heating, Ventilation, and Air Conditioning
HyET	HyET Hydrogen, a leading nonprofit association in the field of electrochemical hydrogen compression.
HYPOWERS	Hydrothermal Processing of Wastewater Solids
IAQ	Internal Air Quality
IFC	International Fire Code
ILI	In-Line Inspection
ILS	Interlaboratory Study Program
INGAA	Interstate Natural Gas Association of America
InSAR	Interferometric Synthetic-Aperture Radar
JCAP	Joint Center for Artificial Photosynthesis
JIP	Joint Industry Program
JPL	Jet Propulsion Laboratory
KCl	Potassium Chloride
kg	Kilogram
kW	Kilowatt
kWhr/kg	Kilowatt Hour Per Kilogram

L	Liter
LAUF	Lost And Unaccounted For
LBNL	Lawrence Berkeley National Lab
LCFS	Low Carbon Fuel Standard
LDC	Local Distribution Company
LEL	Lower Explosive Limit
LHV	Lower Heating Value
LLNL	Lawrence Livermore National Laboratory
LNG	Liquefied Natural Gas
LoRaWan	Low-Power Wide-Area Network
LPG	Liquefied Petroleum Gas
LSB	Low Swirl Burner
LSM	Large Standoff Magnetometry
LSU	Lab-Scale Unit
M	Million
m	Meter
m^2	Square Meter
MAOP	Maximum Allowable Operating Pressure
MCC	Main Combustion Chamber
MCS	Measurement Collection System
MD	Mechanical Damage
MD/HD	Medium-Duty/ Heavy-Duty
MEA	Membrane Electrode Assembly
MES	Marathon Engine Systems
METRON-EVA	METRON's "Energy Virtual Assistant Factory Solution"
MFL	Magnetic Flux Leakage
MicroCHP / mCHP	Micro Combined Heat and Power
mm	Millimeter

MMBTU	Million International British Thermal Units
MMBtu/h	Million International British Thermal Units Per Hour
MS-SOFC	Metal-Supported Solid Oxide Fuel Cell
MSA	Meter Set Assemblies
MT	Metric Tonne
MTR	Mill Test Report
N/A	Not Applicable
NA	North America
NaCl	Sodium Chloride
NAFEM	North American Association of Food Equipment Manufacturers
NBR	Nitrile Butadiene Rubber
NDE	Nondestructive Examination
NDT	Nondestructive Testing
NEEA	Northwest Energy Efficiency Alliance
NFPA	National Fire Protection Association
NG	Natural Gas
NGV	Natural Gas Vehicle
NGVA	NGVAmerica
NIST	National Institute of Standards and Technology
NJIT	New Jersey Institute of Technology
Nm^3/hr	Normal Cubic Meter Per Hour
NMR	Nuclear Magnetic Resonance
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
NPV	Net-Present Value
NREL	National Renewable Energy Laboratory
NYSEARCH	A part of The Northeast Gas Association.
NZE	Near-Zero Emission

O&M	Operations and Maintenance
OEMs	Original Equipment Manufacturer
OGI	Optical Gas Imaging
OIML	International Organization of Legal Metrology
OIT	Odor Intensity Test
OK	Oklahoma
ORC	Organic Rankine Cycle
ORFEUS	Operational Radar For Every drilling string Under the Street
ORNL	Oak Ridge National Laboratory
OSU	Oregon State University
OTD	Operations Technology Development
P&ID	Piping & Instrumentation Diagram
P2G	Power-to-Gas
P2S	Pipe-to-Soil
PCC	Pre-Combustion Chamber
PE	Polyethylene
PEC	Photoelectrochemical
PEM	Proton Exchange Membrane
PEMFC	Proton Exchange Membrane Fuel Cells
PERC	The Property and Environment Research Center
PFD	Process Flow Diagram
PG&E	Pacific Gas and Electric Company
PHET	Plug-In Hybrid Electric Truck
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	Particulate Matter
PNNL	Pacific Northwest National Laboratory
PPE	Personal Protection Equipment
ppm	Parts Per Million
PPQP	Pipeline Personnel Qualification Program
PRCI	Pipeline Research Council International
PSA	Pressure Swing Adsorption
PSMS	Pipeline Safety Management Systems
PV	Photovoltaic
QSI	QuSwami, Inc.
R&D	Research & Development
RAMMS	Rapid Mass Movement Simulation
RANGE	Range of Acceptability for Natural Gas Equipment
RD&D	Research, Development and Demonstration
REPAIR	Rapid Encapsulation of Pipeline Avoiding Intensive Replacement
RESOLVE	An investment and organizational model used by the CPUC.
RFID	Radio-Frequency Identification
RIPED	Research Institute of Petroleum Exploration & Development
RMD	Residential Methane Detector
RNG	Renewable Natural Gas
ROI	Return on Investment
ROW	Right-of-Way
RP	Recommended Practice
RTK	Real-Time Kinematic
RWQCP	Riverside Water Quality Control Plant
S_8	Octasulfur
SBIR	Small Business Innovation Research
SBR	Styrene Butadiene Rubber
SCAQMD	South Coast Air Quality Management District
SCC	Stress Corrosion Cracking
SCFM	Standard Cubic Feet Per Minute

SCG	SoCalGas
SCR	Selective Catalytic Reduction
SEER	Seasonal Energy Efficiency Ratio
SERA	Security Engineering Risk Analysis
SHW	Service Hot Water
SI	Spark Ignition
SMR	Steam Methane Reformer
SMTI	Stone Mountain Technologies, Inc.
SMYS	Specified Minimum Yield Strength
SoCalGas	The Southern California Gas Company
SOFC	Solid Oxide Fuel Cell
SRP	Strategic Research Priority
SSP	Small-Scale Pilot
SSWC	Selective Seam Weld Corrosion
STARS	Solar Thermal Advanced Reactor System
SwRI	Southwest Research Institute
T2M	Technology-to-Market
TAP	Technical Advisory Panel
TC	Trace Constituent
TCD	Thermal Catalytic Decomposition
TDC	Technology Development Center
TEA	Techno-economic Analysis
THP	Thermoelectric Heat Pump
THz	Terahertz
TOU	Time Of Use
TPI	Transient Plasma Ignition
TPS	Transient Plasma Systems, Inc.
TPTS	Two Phase Thermosyphon
TRL	Technology Readiness Level
TSA	Temperature Swing Adsorption
UAS	Unmanned Aviation Systems
UC	University of California
UCI	University of California at Irvine
UCLA	University of California at Los Angeles
UCR	University of California at Riverside
UEF	Uniform Energy Factor
UHC	Unburned Hydrocarbons
UL	UL, LLC
U.S.	United States of America
USG	US Gypsum Co.
USGS	United States Geological Survey
USR	Utonomy Smart Regulator
UT	Ultrasonic Technology
UT-CEM	University of Texas at Austin Center for Electromechanics
UTD	Utilization Technology Development
V	Volt
VIV	Vortex-Induced Vibration
VOCs	Volatile Organic Compounds
VR	Virtual Reality
VTH	Virtual Test Home
WERF	Water Energy Research Foundation
WGS	Water-Gas Shift
WTW	Well-to-Wheels
WVU	West Virginia University
ZNE	Zero Net Energy

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

2020 SUMMARY OF ONGOING AND COMPLETED PROJECTS

LOW CARBON RESOURCES

SUBPROGRAM: LOW CARBON HYDROGEN PRODUCTION

De-Risking Molten Salt Based Methane Pyrolysis Reactors - Phase 1

C-Zero seeks to commercialize a new process for transforming methane into hydrogen and a solid carbon coproduct using high-temperature liquids in a multi-phase pyrolysis reactor with limited carbon dioxide generation. Several engineering challenges must be tackled before C-Zero can build a large-scale prototype unit based on its molten salt reactor design. Two of those engineering challenges are: 1) optimization of gas flow in the reactor and 2) post-processing of the carbon so that it can add value to construction materials such as cement. Project goals were to design and build a scaled-up reactor with optimized gas inlet and bubble holdup, and to explore carbon post-processing techniques and applications like cement additives. The project concluded in Q4 2020 by demonstrating the use of molten NaCl/KCl at 1000°C in a scaled-up metal reactor that operated for 24 hours and had a hydrogen and production rate of 700 g/day and ~2,100 g of solid carbon per day. For reference, the hydrogen production rate at the beginning of the project and the target production rates were 2 and 17 g hydrogen/day, respectively. In addition, C-Zero tested carbon in concrete with up to 7.5% wt.

Cofunders: PG&E, DOE ARPA-E

Start Date: 8/1/2019
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $49,480
Total Project Cost: $2,230,000
Total SCG Cost: $115,000
Total Cofunding: $2,115,000
Benefits:

JPL Catalytic Nonthermal Plasma—Advanced Methane Reforming Technology Development and Commercialization—Phase 1

Susteon is developing a compact distributed hydrogen generator with the goal of producing high-purity pressurized hydrogen at $3 to $4 per kg while capturing carbon dioxide. The CNTP technology converts methane into a hydrogen-rich syngas using a commercial Ni-based SMR catalyst assisted by dielectric barrier discharge non-thermal plasma. The non-thermal plasma activates methane molecules more efficiently than a current thermal-based SMR. The electrification of the reaction, in combination with the higher efficiency from the plasma, drastically lowers the carbon intensity of hydrogen production to <3 kg carbon dioxide per kg hydrogen with the current California electricity grid carbon intensity. In 2020, the project team completed several iterations of plasma formation testing to determine materials of construction, plasma stability, operating conditions, and potential points of failure of a single-tube reactor system design. The results to date show that uniform plasma can be sustained for the methane steam reforming reaction. In 2021, a bench-scale multi-tube system will be tested to obtain process data in order to further advance the development at pilot-scale testing.

Cofunders: N/A

Start Date: 6/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $199,643
Total Project Cost: $392,024
Total SCG Cost: $392,024
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Kore Biosolids Pyrolyzer Field Test

Kore has developed a commercial-scale pyrolyzer that thermochemically converts biomass to syngas. The produced syngas, a mixture of methane, CO, carbon dioxide, and hydrogen, can then be converted to renewable natural gas or renewable hydrogen. The pyrolyzer also has the potential to accept and process waste streams, including forest thinning, municipal solid waste, and food waste. In order to reduce risk and improve the potential for financing future commercial deployments, this field test will verify component integrity at high temperature, feedstock throughput, and gas product quality and composition. The project team will demonstrate operation of feedstock conveyance and drying, pyrolytic conversion, and gas cleanup and cooling. Construction at SoCalGas' Olympic Base site began in 2019 but was delayed by the COVID-19 lockdown. Commissioning and testing of the pyrolyzer are scheduled for 2021.

Cofunders: Kore Infrastructure, SCAQMD

Start Date: 2/13/2017
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $6,100,000
Total SCG Cost: $1,500,000
Total Cofunding: $4,600,000
Benefits:

Linde HydroPrime HC300 (Distributed Steam Methane Reformer - SMR) Purchase for Integration with STARS and Other Low Carbon Hydrogen Technologies

The project's objectives are to 1) purchase the Linde HydroPrime MIN HC300 hydrogen plant capable of producing up to 300 Nm^3/hr of hydrogen and 2) support the integration of the Solar Thermal Reactor System (STARS) Steam Methane Reformer (SMR). The goals of the integration will be to create the option to interchange the Linde-supplied reformer component of the HydroPrime MIN HC300 hydrogen plant with the STARS unit and other SMR technologies, and then to utilize the balance of plant components of the HydroPrime MIN HC300 hydrogen plant (water shift reactor, pressure swing adsorption, heat exchangers, gas processing, instrumentation and control, electrical, etc.) to handle and process both the feed stream and syngas output stream of the STARS unit and other SMR technologies, as appropriate. This will demonstrate and validate the production of a pure hydrogen output stream using several low-hydrogen distributed SMR technologies. In 2020, all engineering work was completed, and the major pieces of equipment were ordered and received at the skid assembly site (Port of Catoosa, OK). The SMR skid equipment will be delivered to SoCalGas in Q3 2021.

Cofunders: N/A

Start Date: 11/15/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $1,432,330
Total Project Cost: $2,540,000
Total SCG Cost: $2,540,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Methane Pyrolysis for Base-Grown Carbon Nanotubes and CO2-Free H2

SoCalGas supported PNNL and WVU in the development of a new patent-pending process for producing carbon dioxide-free hydrogen and valuable solid carbon from natural gas and demonstrating its commercial viability. Based on TCD, the process reduces the net cost of hydrogen through the sale of a valuable crystalline solid carbon coproduct. TCD is promising as it permits the use of lower operating temperatures and, therefore, reduces the energy requirements in comparison to other approaches. Separation of catalyst and carbon product and rapid catalyst deactivation are long-standing challenges to this approach. To address these challenges, a highly efficient bimetallic catalyst—active, stable, and selective toward desirable carbon and hydrogen coproducts—was developed. Second, a process for the separation of catalyst and carbon product, and resynthesis of the catalyst was developed. To date, five cycles of TCD, separation, and catalyst resynthesis have been successfully demonstrated at the bench scale. Next steps to be performed in 2021 include further developing the catalyst to increase its longevity, while also producing larger quantities of separated carbon nanotube product.

Cofunders: C4-MCP, DOE

Start Date: 2/2/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,200,000
Total SCG Cost: $700,000
Total Cofunding: $2,500,000
Benefits:

STARS Corporation Electric Induction Steam Methane Reforming (SMR) Equipment Purchase for Demonstration Project

SoCalGas and STARS Technology Corporation are collaborating to provide the first end-to-end demonstration of commercial hydrogen generators based on SMR technology using modular, advanced, 3D-printed, microchannel reactors and heat exchangers. Unlike traditional SMR processes, these units will rely on a combustion-free, induction heating mechanism to produce hydrogen from biomethane and steam. The effort includes installing, testing, and demonstrating three hydrogen generator modules, each sized to produce ~165 kg/day. Each module employs a network of ~20 reactors and heat exchangers, occupies a footprint of only 20 ft^2 and, when mass-produced in modest numbers per year, is expected to generate hydrogen at production costs of around $5 per kilogram. During 2020, the first of the three modules was designed, component fabrication was initiated, and assembly of the first module was begun. For the first demonstration, SoCalGas has entered an agreement with SunLine Transit to demonstrate the technology at SunLine's location and to use the hydrogen product to fuel its hydrogen fuel cell buses. The first hydrogen generator module will be delivered to SunLine's location by Q2 2021.

Cofunders: N/A

Start Date: 4/1/2020
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $1,722,888
Total Project Cost: $2,175,000
Total SCG Cost: $2,175,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

STARS Manufacturing Supply Chain Development for a Modular Solar-Thermochemical Conversion Platform (PNNL CRADA 387)

In collaboration with the PNNL and OSU, SoCalGas and STARS Technology Corporation are working to develop low-cost manufacturing approaches and technologies for the mass production of chemical process modules containing microchannel reactors and heat exchangers. Co-sponsored by the RAPID Institute, a US Department of Energy Advanced Manufacturing Institute, the effort is assisting with the near-term commercialization of STARS systems for distributed hydrogen production. Goals include lowering equipment costs by improving manufacturing processes, developing innovative equipment designs, and stimulating equipment supply chains. A product of this effort is a patent that was awarded in 2020 based on innovations in additive manufacturing that lowers the weight of the steam-methane reforming reactor by 60% and the costs by over 30%. Future innovations expected under this project include additional improvements in microchannel reactors and heat exchangers, still further improved manufacturing methods that yield further reductions in equipment costs, and integrated systems that yield higher process efficiencies.

Cofunders: DOE, Oregon State University (OSU), STARS

Start Date: 11/2/2018
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $50,000
Total Project Cost: $4,125,000
Total SCG Cost: $550,000
Total Cofunding: $3,575,000
Benefits:

STARS Solar Microchannel Steam Methane Reformer Commercialization (PNNL CRADA 380)

SoCalGas is working with PNNL and STARS Technology Corporation to advance, to a high degree of commercial readiness, a highly efficient, hydrogen production system that features process-intensive, microchannel reactors and heat exchangers plus other chemical process components. Co-funded by the US DOE's Office of Hydrogen and Fuel Cell Technologies and the Solar Energy Technology Office, the effort includes a solar dish-concentrator as the source of energy for the endothermic SMR reaction. Onsite testing at the San Diego State University Brawley Campus has achieved world-record solar-to-chemical energy conversion efficiency (~71%). Onsite work in 2020 was limited due to the COVID-19 pandemic but other progress was made evaluating test data from previous years, including assessments of the performance of the SMR reactor, which features internal recuperation, high-temperature heat exchangers, and other components that fit within the process nacelle at the concentrator's focal point.

Cofunders: DOE

Start Date: 11/1/2017
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,990,000
Total SCG Cost: $750,000
Total Cofunding: $2,240,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Task Order 13 - Honor Rancho Companion Project Blueprint Development

In this project, Momentum worked with SoCalGas to develop a customized, multi-year fund development and communications strategy—a Blueprint—for its Honor Rancho and More-no compressor station modernization efforts. Momentum performed outreach to multiple funding agencies and assembled strategic guidance on project socialization, outreach, and communications; partnership development; team building; permitting; marketing; and more. In particular, Momentum sought to identify funding opportunities that would support onsite hydrogen production, blending hydrogen into the natural gas used to power the compressors, and deploying onsite hydrogen fueling for SoCalGas fleet vehicles.

Cofunders: N/A

Start Date: 6/1/2020
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $45,000
Total Project Cost: $45,000
Total SCG Cost: $45,000
Total Cofunding: $0
Benefits:

Xebec PSA Requisition for Integration with STARS SMR

This project's objective is to requisition the Pressure Swing Adsorption vessel, which will be integrated with the STARS-165 SMR skids being purchased through a separate contract as part of the demonstration effort at SunLine Transit's location. The PSA unit's main function is to separate and recover the hydrogen from the hydrogen-rich syngas stream coming out of the WGS reactor (87.8% v/v recovery rate) into a high-purity (99.999%) hydrogen stream for storage and dispensing The PSA equipment was fully designed, with initial assembly in 2020. Expected delivery at SunLine Transit's location is in Q2 2021.

Cofunders: N/A

Start Date: 4/15/2020
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $268,721
Total Project Cost: $340,000
Total SCG Cost: $340,000
Total Cofunding: $0
Benefits:

SUBPROGRAM: LOW GHG CHEMICAL PROCESSES

Caltech Carbon Dioxide Capture from Oceanwater Using a Highly Efficient Electrodialyzer

Caltech recently demonstrated the lowest equivalent single cell voltage and the lowest electrochemical energy required for electrodialysis using fast redox couple electrolytes for oceanic carbon dioxide removal. The project goal is to leverage experience in innovative membranes development to improve the operating current density in a single cell structure, as well as to construct a multi-cell stack to further advance the state-of-the-art in electrodialyzers, which have disruptive innovation potential for negative emission applications. The project's objectives are to: 1) synthesize and bond a thin cationic (or anionic) layer (5 – 50 µm) directly onto a commercial, off-the-shelf and highly robust CEM, or AEM to further improve water transport to the BPM interface to achieve a 1 Å/cm^{-2} without reaching inflection points for water transport limitation; and 2) couple the electrodialyzer with off-the-shelf membrane contactor to demonstrate carbon dioxide capture at a peak rate of 0.25 L per minute from oceanwater, which is a rate that can produce the carbon dioxide feedstock needed for renewable methane generation in a bench-scale reactor. The project kicked off in Q1 2021.

Cofunders: ARPA-E

Start Date: 11/30/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $200,000
Total Project Cost: $1,050,000
Total SCG Cost: $200,000
Total Cofunding: $850,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

FLECCS—Rapid Temperature Swing Adsorption (TSA) for CO2 Capture

This project will further develop and demonstrate a novel rapid-cycle TSA carbon dioxide capture technology for use with natural gas power plants and industrial processes that have variable load profiles, with the goal to advance the commercialization of technology that effectively captures carbon dioxide emissions from natural gas power plants and other industrial processes. It will model the TSA carbon dioxide capture technology coupled with a natural gas combined cycle power plant located in Southern California, where turndown ratios range from 25% to 100% due to high renewables market penetrations. Technologies that mitigate GHG emissions from fossil power plant flue gas will benefit ratepayers by improving air quality and reducing the carbon footprint of fossil power plants. The project's objectives are to: 1) demonstrate a solid-sorbent-based rapid-cycle thermal swing adsorption system for carbon dioxide capture applications from fossil power plants flue gas; 2) model the coupling of the carbon capture and storage with power plant operation and optimize for maximum NPV in a high renewable energy penetration environment; and 3) perform techno-economic and T2M analysis.

Cofunders: ARPA-E

Start Date: 9/1/2020
End Date: 9/1/2021
Status: Active
2020 Funds Expended: $70,000
Total Project Cost: $859,009
Total SCG Cost: $70,000
Total Cofunding: $789,009
Benefits:

Low Temperature Regeneration Sorbents for Direct Air Capture of CO2

The project seeks to develop solid sorbent materials that can be regenerated at much lower temperatures than state-of-the-art materials and can be made into structured sorbent beds for low pressure drop operation to significantly lower the cost of direct air capture of carbon dioxide. The objective is to develop sorbent materials with the required properties and improvement, and ultimately increase the carbon dioxide desorption rate by several orders of magnitude at desorption temperatures of ~80°C. By the selection of amine-based sorbents as starting material incorporating the proposed novel catalysts with the starting materials, the underlining properties of the proposed sorbent materials are expected to be highly selective for carbon dioxide from other components in air, to have improved carbon dioxide adsorption and desorption kinetics due to the incorporation of the proposed novel catalysts, to be able to be made into structured adsorbent beds with low pressure drop, to be stable in high-humidity air, and most importantly, to be able to be regenerated at temperatures lower than the state-of-the-art sorbents for reduced energy consumption. The project will kick off in Q1 2021.

Cofunders: DOE

Start Date: 10/1/2020
End Date: 3/31/2022
Status: Active
2020 Funds Expended: $100,000
Total Project Cost: $900,000
Total SCG Cost: $100,000
Total Cofunding: $800,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Momentum GFO-19-901 FPIP Hyperlight Proposal

The purpose of this project was to prepare the initial concept and secure DOE or CEC funding to develop a low-cost, high-efficiency carbon dioxide capture system using an existing concentrated solar-thermal power technology. The system will be based on Hyperlight Energy's Hylux™ linear Fresnel concentrated solar-thermal system that was developed by SoCalGas and successfully tested at San Diego State Brawley in 2019. If successful, the Hylux™ will achieve dual purposes: solar power generation and carbon dioxide capture.

Cofunders: N/A

Start Date: 9/6/2019
End Date: 3/31/2020
Status: Completed
2020 Funds Expended: $26,526
Total Project Cost: $60,000
Total SCG Cost: $60,000
Total Cofunding: $0
Benefits:

Proton Exchange Membranes (PEM) CO2 Electrolyzer Scale-up to Enable MW-Scale Electrochemical Modules

Opus 12 has achieved state-of-the-art performance for carbon dioxide electrolysis to CO. Scaling up the PEM carbon dioxide electrolyzer system to MW-scale enables industrially relevant applications where tremendous amounts of carbon dioxide can be converted into CO and plastics. The next step is scaling up the MEA active area to 1,600 cm^2. This MEA area is needed to build MW-scale stacks capable of over 800 kg of carbon dioxide conversion per day. Opus 12 has identified five high-level project objectives needed to support that scale-up: 1) the creation of a high-performing larger 1,600 cm^2 MEAs and fabrication protocol; 2) PEM carbon dioxide electrolyzer stack designed for the larger 1,600 cm^2 MEA; 3) new experimental methods and theoretical models for the transport layers, MEA, and catalyst characterization to accelerate future MEA development, manufacturing, and quality control; 4) demonstration of industrially relevant performance metrics; and 5) TEA and lifecycle analyses quantifying the greenhouse gas emissions reductions and economic competitiveness of electrochemical CO production compared to conventional methods. The project will kick off in 2021.

Cofunders: DOE BETO, Opus 12 Company R&D Funding

Start Date: 11/30/2020
End Date: 8/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,125,000
Total SCG Cost: $500,000
Total Cofunding: $2,625,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Plasma Assisted Catalytic Conversion of Carbon Dioxide and Propane to Propylene and CO

The intent of this project is to develop a novel CNTP technology utilizing metallic/bi-metallic catalysts in a commercially scalable reactor design, with the ultimate goal being commercial adoption of this technology for utilizing carbon dioxide as a soft-oxidant to produce ethylene and propylene from ethane and propane. The key step in this conversion is the plasma assisted catalytic conversion of carbon dioxide to carbon monoxide (CO) and oxygen radicals. These oxygen radicals subsequently react with ethane and propane to form ethylene and propylene. Preliminary techno-economic analysis shows that greater than 50% yields of ethylene and propylene from the proposed technology can provide cost parity with existing production technology for ethylene and propylene without any financial incentives for carbon dioxide utilization. Project objectives include: 1) plasma reaction system modification and setup; 2) catalyst preparation, characterization, and evaluation under relevant operating conditions; 3) carbon dioxide oxidative dehydrogenation in the plasma reactor with and without catalyst; and 4) process modeling. The project will kick-off in Q1 2021.

Cofunders: DOE

Start Date: 12/1/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $120,000
Total Project Cost: $1,120,000
Total SCG Cost: $120,000
Total Cofunding: $1,000,000
Benefits:

TCF-19-17862 Integrated Capture and Conversion of CO2 Carbon Dioxide to Methanol (ICCCM) Process Technology

SoCalGas supported PNNL in developing a prototype system that integrates the capture and catalytic hydrogenation of carbon dioxide into methanol in the same solvent and demonstrating its commercial viability. The patent-pending integrated carbon dioxide capture and conversion process has the potential for significant cost savings relevant to the more common approaches to carbon capture, use, and storage. An integrated catalyst/solvent system suitable for combined capture and conversion was first demonstrated using batch reactor processing with a precombustion solvent system. In 2020, the processing was successfully demonstrated when using industrially relevant and scalable continuous-flow reactors. PNNL also demonstrated the conversion of carbon dioxide and hydrogen to methanol with 71% selectivity using one of PNNL's leading post-combustion capture solvents—likely the first time that the formation of methanol has been demonstrated using a post-combustion solvent in the presence of a heterogenous catalyst. Work is underway in 2021 to advance the integrated catalyst/solvent system by improving catalytic activity required for commercial adoption.

Cofunders: DOE

Start Date: 10/1/2019
End Date: 10/1/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,200,000
Total SCG Cost: $600,000
Total Cofunding: $600,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: RENEWABLE GAS PRODUCTION

Caltech Bench-Scale Photoelectrochemical (PEC) Hydrogen Generator

The focus of the project is to design, develop, and demonstrate a PEC water-splitting prototype with an active light harvesting area of ~ 1 m^2 that operates at >10% solar-to-hydrogen conversion efficiency. The large-area PV-driven, MEA prototype hydrogen generator will be tested under real-world sunlight conditions and will be used to generate hydrogen at a peak rate of >1 L per min. The project's objectives are to: 1) design and fabricate custom Si-based photoeletrodes for PEC hydrogen prototype; 2) design and construct ultra-low-cost electrochemical water-splitting assemblies; and 3) integrate PV and electrochemical unit and demonstrate the PEC hydrogen production at a peak rate of 1 L per min under real-world/outdoor conditions. The project will kick off in Q1 2021.

Cofunders: DOE SBIR with Tetramer Phase II, DOE EERE with Proton Onsite

Start Date: 11/30/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $300,000
Total Project Cost: $1,080,000
Total SCG Cost: $300,000
Total Cofunding: $780,000
Benefits:

Grant Farm Consulting Agreement

Grant writing consulting to help secure DOE and CEC funding opportunities. This included pursuing new funding opportunities where cost-sharing potential is high. The Grant Farm supported the development of funding opportunities to develop a low-cost, high-efficiency solar thermal carbon dioxide capture system. The Grant Farm also helped coordinate existing grants' reporting requirements by providing timely project documentation to the CEC and DOE.

Cofunders: N/A

Start Date: 10/1/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $40,233
Total Project Cost: $153,000
Total SCG Cost: $153,000
Total Cofunding: $0
Benefits:

Grant Farm Consulting Services

Grant management services for HYPOWERS Demonstration Facility to demonstrate conversion of sewer sludge at the Contra Costa Water Treatment Facility into biodiesel and renewable gas. Grant Farm helped Genifuel develop its proposal to the CEC, which resulted in a successful funding award from CEC. Grant Farm developed project memos and coordinated regular interactions between the project team and the CEC.

Cofunders: N/A

Start Date: 2/1/2019
End Date: 2/1/2020
Status: Completed
2020 Funds Expended: $28,334
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Grant Farm Consulting Services II

Grant Farm helped coordinate, manage, and implement future funding strategies for the RD&D program, including assisting in the development of a 2019 Annual Report and Research Plan, coordinating discussions with research partners to identify research gaps that would enhance the impact of RD&D funded work.

Cofunders: N/A

Start Date: 5/1/2019
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $42,500
Total Project Cost: $67,500
Total SCG Cost: $67,500
Total Cofunding: $0
Benefits:

Hydrogen Blending on the Natural Gas System

This project conducted research and analysis at both a project-specific and a general level. Both commercial (LCFS pathway analysis, revenue strategy and business case development) and technical (blending dynamics, blending system design, simulation, and validation) work streams were pursued. Following extensive literature reviews and collaboration with international organizations engaged in hydrogen blending system design and construction (i.e. HyDeploy), the end results of the effort were the development of a reusable, SoCalGas-approved blending system design with supporting computational fluid dynamics analysis, control narrative, and test results, as well as a low-carbon-fuel-standard pathway. The SoCalGas-approved blending system will be further developed to be validated and demonstrated in a real-life setting starting with an isolated section of primarily polyethylene plastic distribution system in SoCalGas' service territory.

Cofunders: N/A

Start Date: 8/1/2019
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $126,207
Total Project Cost: $150,000
Total SCG Cost: $150,000
Total Cofunding: $0
Benefits:

HyET Hydrogen—Electrochemical Hydrogen Compression and Purification Skid Procurement

HyET's EHPC technology is based on selective transport of hydrogen through an MEA. The primary objective of this project is to procure a pilot EHPC skid to demonstrate the technology and collect valuable performance parameter data to help improve the efficiency and capital cost of the EHPC system in future commercial applications. The EHPC systems will be designed for a nominal hydrogen production capacity of 10 and 100+ kg hydrogen/day for pilot and commercial scale, respectively. In 2020, HyET, working closely with SoCalGas, designed the EHPC skid and developed all the associated engineering drawings, PFDs, and P&IDs; procured all of the necessary parts to build the skids; and retained a system integrator to assemble them. The system will be ready for debugging, factory acceptance testing, delivery, installation, commissioning, and demonstration in Q2 2021 at the SoCalGas Engineering Analysis Center. To test the technology, SoCalGas will blend hydrogen, in concentrations from 3 to 15%, with methane in a simulated pipeline environment.

Cofunders: N/A

Start Date: 3/9/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $531,963
Total Project Cost: $534,500
Total SCG Cost: $534,500
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

HYPOWERS—Hydrothermal Processing of Wastewater Solids Phase 2 (GFO-18-602)

The goal of this project is to design, build, and commission a CEQA-exempt, demonstration-scale Hydrothermal Processing of Wastewater Solids—HYPOWERS—Demonstration Facility located at the Central Contra Costa Sanitary District Wastewater Treatment Plant in Martinez, California. Partially funded by a grant from the DOE, the project will scale up an innovative technology that converts wastewater solids—sludge and biosolids—into RNG and biocrude oil. When operational, the facility will produce RNG and a biocrude product that will be processed by PNNL into "drop-in" renewable diesel. RNG and diesel will be produced at annualized rates of 158 MMBTU (1,174 DGE) and 113,804 gallons (109,725 DGE), respectively. In 2020, the project continued to seek external sources of funding to complement DOE- and CEC-approved cofunding. Plans for 2021 include finalizing the contract and initiating field construction.

Cofunders: DOE, CEC, WERF

Start Date: 7/1/2019
End Date: 12/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $18,000,000
Total SCG Cost: $0
Total Cofunding: $18,000,000
Benefits:

HYPOWERS Phase 2—Sulfur-Resistant CHG Catalyst Development (PNNL CRADA 442)

PNNL has developed and licensed CHG technology to Genifuel. The CHG catalyst is ruthenium on a graphite substrate. Its action is to reduce the carbon in the feed to methane until all available hydrogen is consumed. The target biomass for the HYPOWERS project is sewage sludge, which contains sulfur. CHG technology can produce RNG and hydrogen from such waste streams. Like the noble metals and other catalysts, ruthenium is deactivated by exposure to sulfur. The goal of this project is to overcome catalyst sulfur poisoning to enable commercially viable CHG processing of HTL aqueous waste stream, with reasonable catalyst turnover rates. HTL is the first step of processing for sewer sludge and forms the feedstock to the CHG unit. The project identified potential sulfur tolerant catalysts that are active in the sulfided form. In 2020, these catalysts were synthesized, characterized, and tested in a continuous-flow lab-scale CHG reactor using actual aqueous product from HTL of sewage sludge. One sulfided Ru/C catalyst possesses a stable CHG performance of 480+ hours time-on-stream. In 2021, PNNL plans to continue improving the activity of the unsupported sulfided CHG catalysts.

Cofunders: N/A

Start Date: 8/1/2019
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $500,000
Total SCG Cost: $500,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Joint Center for Artificial Photosynthesis (JCAP) Industry Advisor Membership

JCAP was established in 2010 as a DOE Energy Innovation Hub that aims to find new and effective ways to produce fuels using only sunlight, water, and carbon dioxide. JCAP is led by a team from Caltech and brings together more than 100 world-class scientists and engineers from Caltech and its lead partner, LBNL. JCAP also draws on the expertise and capabilities of key partners from the University of California campuses at Irvine and San Diego, and the SLAC National Accelerator Laboratory. The many benefits of artificial photosynthesis include increased energy independence and highly efficient storage and dispatch of solar energy. Supporting the development of the foundational science and core technologies required for solar-fuel generation is the first step toward an investment in a future sustainable energy industry. SoCalGas served on JCAP's Industry Advisor Board to help guide research toward high-value fuels, specifically methane or RNG.

Cofunders: N/A

Start Date: 1/12/2016
End Date: 1/12/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $502,020
Total SCG Cost: $502,020
Total Cofunding: $0
Benefits:

LLNL Advanced Manufactured Reactors for Microbial Electromethanogenesis Phase 2

Most of the cost of biogas production is in the removal of inerts and contaminants, a cost particularly prohibitive for small-scale biogas producers, which collectively make up the majority of biogas potential. A more efficient approach is to convert the carbon dioxide to methane, upgrading the gas to pipeline-quality, rather than removing the carbon dioxide. Methanogenic microbes can convert carbon dioxide to methane with high energy efficiency and selectivity. LLNL worked with Stanford University and SoCalGas to develop a proof-of-concept reactor with a process efficiency of 0.3 g/Whr. The team plans to generate high-surface-area electrode materials that reduce energy consumption, increase volumetric productivity, and have scalable surface area. In 2020, LLNL achieved 97-99% of single-pass conversion efficiency of carbon dioxide in microbial testing of electro-biomethanation using both carbon aerogel and stainless-steel electrodes, and also verified that cathode potentials were stable over 50 days of continuous operation in microbial testing. In 2021, work will focus on scaling up tubular reactors, testing on simulated biogas, and reducing energy requirements.

Cofunders: DOE

Start Date: 9/5/2018
End Date: 6/11/2021
Status: Active
2020 Funds Expended: $100,000
Total Project Cost: $1,167,843
Total SCG Cost: $750,000
Total Cofunding: $417,843
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Low Cost/Low Energy Hydrogen and Sulfuric Acid Co-Production via Electrolysis

The production of hydrogen and ordinary Portland cement are responsible for ~7% of global GHG, more than attributed to cars. California is a top-3 producer of both hydrogen and cement. Both are considered difficult to decarbonize because, currently, their production results in emissions from burning fossil fuels for energy and process emissions from the chemical reaction involved in the product. Brimstone Energy is building a technology to produce low-cost hydrogen and cement without process emissions. The Brimstone sulfuric acid electrolyzer consumes <25 kWhr/kg hydrogen, making it <50% as energy intensive as conventional water electrolysis. This process could produce >1 million MT of low-cost hydrogen from California's cement demand alone. In 2020, Brimstone built a 50 cm^2 sulfuric acid electrolyzer cell which, when optimized, is capable of producing 25-100 g of hydrogen per day depending on current density. In 2021, the plan is to 1) optimize at >0.5 Å/cm^2 current density and at <0.4 V cell voltage and 2) place these cells in series in order to build a 1 kg/day cell and demonstrate its long-term operational efficiency and superior economics to traditional water electrolysis.

Cofunders: ARPA-E, PG&E, Cyclotron Road, VC

Start Date: 11/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,525,000
Total SCG Cost: $50,000
Total Cofunding: $3,475,000
Benefits:

NREL CRADA No. CRD-19-809 P2G Systems Integration & Optimization

Power-to-gas biomethanation and other gas fermentation processes can be challenged with hydrogen mass transfer rates due to the gas' inherent low solubility in water. Work completed in 2020 included the design of the electrolyzer system incorporating intellectual property developed at NREL and licensed to SoCalGas. Working with PlugPower, a 20kW electrolyzer stack was specified and ordered in 2020 with expected delivery in 2021. Also in 2020, patent applications were submitted domestically and internationally that will reduce the capital cost and improve the efficiency of a closely-coupled electrolyzer/bioreactor system, ultimately providing a lower production cost for renewable natural gas. In 2021, the hydrogen-producing electrolyzer stack will be installed into the compressor-less electrolyzer balance of plant to feed the custom 18-bar bioreactor vessel containing methanogens from Electrochaea. The impact of the IP will be further investigated and evaluated in 2021 to quantify the overall cost reductions identified in the patents.

Cofunders: DOE

Start Date: 5/1/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $209,970
Total Project Cost: $4,400,000
Total SCG Cost: $700,000
Total Cofunding: $3,700,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

NREL Hydrogen Pathways Study

The study entails identifying pathways for wholesale market access to hydrogen production facilities and evaluating the cost and performance implications for each pathway. The project is considering eight potential regulatory/special pathways for access to wholesale power prices within California and the Western Electricity Coordinating Council. Pathway options include co-location, demand response, direct wholesale participation, and access to federal hydropower. Three key pathways have been evaluated including retail TOU, Real-Time Pricing, and direct wholesale market access. Preliminary results indicate that the best-case pathway (direct access to wholesale electricity) provides high capacity utilization of electrolyzers, and the hydrogen production cost has a strong correlation with the average locational marginal price on the grid. Moving from retail TOU to real-time pricing enables a reduction of ~25.9% in hydrogen production costs. Next steps are to gather and integrate final cost/pricing data for the pathways, finalize modeling runs and scenarios, and visualize results, with final results expected in Q1 2021.

Cofunders: N/A

Start Date: 1/1/2020
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $189,503
Total Project Cost: $205,000
Total SCG Cost: $205,000
Total Cofunding: $0
Benefits:

NREL Impacts of Hydrogen Blending in Natural Gas Networks

The project objective is to create a modeling framework for an integrated model that can consider hydrogen production, blending hydrogen into the natural gas system, and the resulting impacts on the electric grid. Several metrics will be developed, including for: 1) system operation including gas composition throughout the gas network; 2) determining the lifetime impacts of hydrogen blending on the gas network equipment; and 3) impacts of fuel composition on gas generators on the electric grid. Project deliverables include a modeling framework that integrates a hydrogen production model, injection into the gas grid, a gas system model, and an electric grid model to enable the characterization and understanding of the benefits and impacts of hydrogen blending. A test system will also be developed to showcase the capabilities of the integrated model. Finally, the modeling framework will be commercialized through public release. Project partners include SoCalGas, The Institute of Gas Innovation and Technology, and Encoord. The project kicked-off in December 2020 with a discussion of the overall scope. Next steps include development of the overall model structure and test system.

Cofunders: N/A

Start Date: 8/1/2020
End Date: 8/1/2021
Status: Active
2020 Funds Expended: $25,000
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

Reliability

Safety

Operational Efficiency

Improved Affordability

Environmental: Reduced GHG Emissions

Environmental: Improved Air Quality

NREL Multi-Party CRADA No. CRD-18-00775 Biomethanation to Upgrade Biogas to Pipeline Grade Methane

The purpose of this project is to develop and de-risk an adaptable biomethanation process to upgrade biogas waste streams to RNG. Work completed in 2020 included design and specification of all of the major components and systems of the biomethanation process, including a 16' long custom trailer with research and control rooms delivered in 2020. Lessons learned from operations of the SoCalGas 700L bioreactor system at NREL in 2020 informed improvements of the nutrient dosing system, bioreactor vessel design, and balance of plant needed to produce pipeline-quality RNG at the output of the bioreactor system. In 2021, the project has moved into procurement and fabrication of all major components, including a custom reactor vessel from Parr Instruments. Operation of the 20L scaled-down system is expected to begin toward the end of 2021 with biocatalysts supplied by partner Electrochaea GmbH.

Cofunders: DOE, Electrochaea

Start Date: 7/31/2019
End Date: 7/29/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,305,000
Total SCG Cost: $5,000
Total Cofunding: $2,300,000
Benefits:

Opus 12 Methane Conversion System—Phase II

Electrochemical technology that converts the carbon dioxide content in raw biogas to pipeline-quality RNG is a critical improvement in the science of upgrading waste emissions to renewable gas. This Phase-II work builds on the success of an initial feasibility study in 2018. In Phase II, SoCalGas, PG&E, and Opus 12 were tasked with further increasing methane reduction from carbon dioxide, relative to Phase I results, by improving partial current density to methane. Current densities above 200 mA/cm^2 are considered industrially relevant. Opus 12 screened various novel catalysts produced in house or with partners, as well as commercial catalysts. Additionally, the optimization of MEA manufacturing and testing conditions was evaluated to further boost methane production. A maximum of 50% faradaic efficiency was achieved at 400 mA/cm^2 and 40% at 500, 600 and 700 mA/cm^2 settings. In addition, the stability of the performance at 200 and 300 mA/cm^2 was improved by a combination of MEA design and reactor optimization, achieving eight hours of stability at 50-60% faradaic efficiency at 300 mA/cm^2 and a new internal record of 12 hours of stability at 200 mA/cm^2.

Cofunders: PG&E, NASA Phase II SBIR, DOE – Advanced Manufacturing Office

Start Date: 1/31/2019
End Date: 1/31/2020
Status: Completed
2020 Funds Expended: $25,000
Total Project Cost: $1,025,000
Total SCG Cost: $150,000
Total Cofunding: $875,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Scaling of Microbial Power to Gas Conversion for Long Term Operation (M2018-011)

Electricity produced from renewables is becoming a more abundant and common resource. However, this electricity fluctuates and is generally lost when not used following production. A viable and long-term solution to storing this excess renewable energy is needed. One desirable and promising path to storing intermittent, renewable electrical energy is Power-to-Gas technology. The goal of Phase I was to test and identify bottlenecks in the long-term operation of microbial electromethanogenesis for power-to-gas operations. The work comprised three activities: 1) evaluate growth and metabolism of microbial cells during long-term operation of a bioelectrochemical reactor (Run1); 2) data analysis and interpretation with respect to microbial viability and performance and recommendations for improved operation; and 3) repeat experiments with incorporated modifications based on the findings from the previous work. Despite the shutdown of laboratory work due to COVID-19, Phase I was completed. In 2020, Phase II began, with the goal of identifying the methanogenic archaea most suitable for intermittent electromethanogenesis for further study of the dynamics and robustness of predictable and unpredictable electrical power supplies.

Cofunders: NYSEARCH Members

Start Date: 12/10/2018
End Date: 4/31/2022
Status: Active
2020 Funds Expended: $55,435
Total Project Cost: $805,625
Total SCG Cost: $87,720
Total Cofunding: $717,905
Benefits:

Speeding Anaerobic Digestion Through CO2 Microbubbles

This project aims to introduce carbon dioxide microbubbles at full scale, in collaboration with Riverside Water Quality Control Plant. RWQCP has sufficient digestion capability to dedicate two, 1-million-gallon digesters to this trial. One digester will serve as the "control" (operated as normal) and the second digester will integrate the Perlemax technology into its heat exchanger recirculation loop ("experimental"). Initially, both digesters will employ the same sludge feed rate. The experimental digester will start with the lowest flow of carbon dioxide microbubbles (equates to 0.23% of digester volume per day of carbon dioxide). After a robust baseline of performance change has been established, the flow rate of sludge and carbon dioxide will be increased in order to achieve maximal volatile solid conversion and methane production rates (to a maximum 0.69% digester volume of carbon dioxide per day). In 2020, engineering design and procurement activities were completed despite significant project delays due to COVID-19.

Cofunders: CalSEED

Start Date: 6/1/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $80,000
Total Project Cost: $300,840
Total SCG Cost: $150,840
Total Cofunding: $150,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Sustainable Production of Methane from CO2, Water and Sunlight

The project objective was to survey and develop comprehensive technology pathways for the sustainable generation of methane from carbon dioxide, water, and sunlight. To produce cost-competitive, zero-GHG-emission methane at scale, carbon dioxide, water, and renewable power sources must all come together synergistically. The JCAP team evaluated the performance of state-of-the-art materials, components, and devices for both carbon dioxide capture and carbon dioxide conversion to methane to determine the most viable pathways for commercialization. JCAP compared four main carbon dioxide methanation pathways: thermochemical, biochemical, photo-electrochemical, and electrochemical. JCAP applied a standard discounted cash flow method to each technology. The results indicate that thermochemical or biochemical methane generation using carbon dioxide captured from point sources and hydrogen produced from low-temperature electrolysis powered by renewables are the most cost-competitive pathways in the short term. Importantly, the study found that at an electricity price of $10/MWh, a cost of $800/ton of methane can be achieved.

Cofunders: N/A

Start Date: 2/1/2020
End Date: 2/28/2021
Status: Active
2020 Funds Expended: $170,000
Total Project Cost: $170,000
Total SCG Cost: $170,000
Total Cofunding: $0
Benefits:

TCF-19-17586 LLNL Composite Sorbents - Enabling Economical Biomethane Production

LLNL and SoCalGas are working to refine and demonstrate a new class of sorbents for upgrading raw biogas to biomethane. This approach could significantly reduce cost barriers to biomethane production, enabling small producers to leverage this renewable energy resource to generate revenue. Project goals are to determine the economics and feasibility of a full-scale demonstration at the completion of the two-year project. The focus of the technology maturation activities will be to: 1) demonstrate longevity of the sorbent over an industrially-relevant time scale; 2) understand effects of H_2S contamination; 3) scale up production of sorbent; and 4) scale up the system by ~4 orders of magnitude. In 2020, LLNL devised a new composite material formulation compatible with large-scale manufacturing and built and operated a Lab-Scale Unit (LSU), a bench-top, integrated, automated sorbent system suitable for long term (1,000 hour) testing. In 2021, LLNL in partnership with Xebec, will operate an SSP at Xebec's testing facility. The final project deliverable is a technoeconomic analysis of SSP for future maturation activities.

Cofunders: DOE

Start Date: 10/15/2019
End Date: 10/15/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $500,000
Total SCG Cost: $250,000
Total Cofunding: $250,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UCI Clean Energy Research Center Cofunding

Several current trends are increasing the urgency of addressing the energy-water nexus in an integrated way, both in the US and China. Precipitation and temperature patterns are undergoing rapid change with increasing frequency and intensity of extreme events. Population growth and regional migration trends indicate that the population in certain arid areas (e.g. the Southwest United States) is likely to continue to increase, further impacting the management of both energy and water systems. The introduction of new technologies in the energy and water domains could shift water and energy demands. The mission of the CERC-WET consortium is to build and transfer a foundation of knowledge, technologies, human capabilities, and relationships that position the US, relevant industries, non-profits, and research peers in China to thrive in a future with constrained energy and water resources in a changing global climate. Dr. Ashok Gadgil from University of California, Berkeley led the US consortium. Liu He, from the Research Institute of Petroleum Exploration & Development, led the Chinese consortium.

Cofunders: For the US consortium: DOE, University of California and participating stakeholders

Start Date: 8/15/2016
End Date: 8/15/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $25,000,000
Total SCG Cost: $500,000
Total Cofunding: $24,500,000
Benefits:

UCI Five Points Solar P2G Feasibility Study

The goal of this project is to design a renewable gas energy storage system at the Five Points and/or Burford-Giffen solar power generation sites to help the University of California achieve carbon neutrality. One major accomplishment of 2020 involved completing the evaluation of various electrolyzer technologies and commercially available products to determine their feasibility for incorporation into the power-to-gas system design. A report on this electrolyzer technology evaluation was produced and delivered. In addition, the team was able to analyze various means of purchasing and selling power, transmitting and distributing power, purchasing and selling gas, and transmitting and distributing gas at the Five Points and Burford-Giffen sites to determine the most favorable market conditions for the power-to-gas system design. A report on these market conditions was also produced and delivered. Permission was received from all parties supporting this project to engage with a project developer, Ørsted, to assist with a particular power-to-gas system design. Continuing work in 2021 is underway to develop the power-to-gas system design.

Cofunders: University of California Office of the President, Pacific Gas and Electric

Start Date: 4/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $40,000
Total Project Cost: $95,901
Total SCG Cost: $95,901
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UCI Marginal Methane Emissions Model Research

A new cause-based approach was used to estimate the change in methane emissions from the natural gas system resulting from a change in throughput. This approach was shown to be more accurate than assuming that methane emissions vary one-for-one with throughput. The results show that methane emissions change with throughput but the relative change in emissions is less than the relative change in throughput. There are many components in the natural gas system that emit the same amount of methane to the atmosphere regardless of their operational mode, meaning some emissions sources have no or only partial dependence on throughput. As a result, reducing natural gas consumption in the future will not yield a directly proportional reduction in the methane emissions. The results of this work were published in academic journals (MacKinnon et al., 2018, Journal of the Air & Waste Management Association; Heydarzadeh et al., 2020, Applied Energy) and will help energy policymakers better understand the effect of policies aimed at reducing natural gas use on greenhouse gas emissions and where such policies should be applied (e.g. system operator or end user).

Cofunders: N/A

Start Date: 5/16/2016
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $338,434
Total SCG Cost: $338,434
Total Cofunding: $0
Benefits:

UCI Transformation of the Natural Gas System Study

The objective of this project is to assess optimal pathways for the adoption and use of high fractions of renewable gas using the existing, adapted, and/or replaced natural gas infrastructure. The work draws heavily on ongoing efforts in Europe to address this topic, including the H21 hydrogen conversion project in the Northern UK and various studies and demonstration projects sponsored by the European Union and European trade organizations. Work to date highlights the importance of understanding the future delivered cost (price) of renewable methane versus renewable hydrogen. If renewable methane can be produced at a similar unit cost to renewable hydrogen, there is little incentive to invest in infrastructure or end-use adaption and use of "drop in" renewable methane is the optimal approach. However, if renewable hydrogen proves to be substantially less expensive, the payback time in fuel cost savings for investment in adapted or new infrastructure and end-use devices becomes attractive. Continuing work in 2021 will refine estimates of the overall cost of alternative approaches, as well as uncertainty in the estimate.

Cofunders: N/A

Start Date: 2/21/2020
End Date: 8/31/2021
Status: Active
2020 Funds Expended: $125,000
Total Project Cost: $350,000
Total SCG Cost: $350,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

US Hydrogen Study

SoCalGas joined a coalition of major oil and gas, power, automotive, fuel cell, and hydrogen companies that came together to develop a Road Map to a US Hydrogen Economy. This comprehensive Road Map details how the US can expand its global energy leadership by scaling up activity in the rapidly emerging and evolving hydrogen economy as policymakers and industry work together and take the right steps. This Road Map shows how critically important hydrogen is to achieve a lower-carbon energy mix, and with the right actions now, can reinforce US energy leadership and strengthen the economy. In addition, if the right actions are taken now, a competitive hydrogen industry could meet 14 percent of US energy demand by 2050.

Cofunders: Under the leadership of FCHEA, a consortium of 20 major energy industry companies including Chevron, Exxon, and Shell

Start Date: 3/4/2019
End Date: 3/1/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $500,000
Total SCG Cost: $25,000
Total Cofunding: $475,000
Benefits:

Use of the Natural Gas Grid as a Long Duration Energy Storage Resource

The objective of this project is to determine the extent to which use of the natural gas grid to provide long-duration grid storage and renewables firming improves the overall cost and environmental performance of the electric grid at high renewable fractions. The initial phase of work developed a levelized cost comparison of a range of technologies capable of providing grid storage for durations longer than 12 hours. Among others, pumped hydro, compressed air, and thermal storage technologies were compared to HES using the gas grid for transmission and storage of blended hydrogen for later reconversion in existing thermal generation resources. The CPUC RESOLVE capacity expansion model was also used to model HES using the gas grid and existing generation. The analysis validated that the gas-grid use case improves the dispatch (lower overall cost and less curtailment) when renewable gas supply is available for dispatchable power generation at prices below $24/MMBtu commodity price. Analysis is ongoing in 2021 to assess the dynamics of hydrogen production and use for renewables firming, using the grid dispatch model HiGRID.

Cofunders: N/A

Start Date: 8/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $100,000
Total Project Cost: $300,000
Total SCG Cost: $300,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

West Biofuels Renewable Gas Separation System and Techno-Economic Assessment

The project objectives were to: 1) assess the separation efficiency of gas hydrates in producing high-purity renewable methane from mixed alcohol tail gas and 2) develop an integrated technoeconomic model to calculate production cost(s) and identify key cost drivers within the West Biofuels biomass-to-mixed alcohol process. Ongoing experiments validated the proof of concept by showing that under appropriate thermodynamic conditions, gas hydrates selectively concentrate methane and higher molecular weight species within the mixed alcohol tail gas stream. However, both the time necessary for hydrate formation and the lower than desired per-stage separation efficiency suggest alternative and/or supporting separation processes may be required. Modeling efforts have focused on modifying existing NREL mixed alcohol production models to reflect recent process modifications. Continuing work will focus on development of the downstream separation scheme to reach pipeline-quality renewable methane before beginning in-depth economic analyses. 2021 efforts focus on modifying the existing NREL MAS model to reflect the anticipated design and provided a calculated data set.

Cofunders: CEC

Start Date: 10/1/2019
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $200,000
Total Project Cost: $200,000
Total SCG Cost: $0
Total Cofunding: $200,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GAS OPERATIONS

SUBPROGRAM: ENVIRONMENTAL & SAFETY

A Process-Based Approach to PSMS, Phase II (OTD 8.18.f.2)

The project objective is to develop tools using the Business Process Modeling and Notation System assisting utilities with creating, updating or validating their PSMS. This builds upon the work completed in Phase 1, where American Petroleum Institute Standard 1173 was broken down into its core requirements and aligned with business processes as a methodology of enterprise-level management of PSMS. The Business Process Modeling and Notation System will be used to identify business units that are critical to an organization's PSMS, and how those units interact in the PSMS across the organization. This project will deliver recommendations and best practice documentation.

Cofunders: OTD Members

Start Date: 12/4/2020
End Date: 8/4/2022
Status: Active
2020 Funds Expended: $5,000
Total Project Cost: $235,000
Total SCG Cost: $8,103
Total Cofunding: $226,897
Benefits:

Aboveground Service Tee Identification and Mapping System (8.20.j)

In this project, an aboveground three-dimensional electromagnetic technology used for locating subsurface metallic infrastructure will be evaluated to see if PE service tees can be located by identifying the metallic cutter within the service tees. Identifying the accurate location of buried PE service tees for O&M purposes will eliminate costly "dry" excavations. Proof of concept testing has been conducted, demonstrating the viability of the concept. This project will classify a wide variety of tees and provide testing and results of geospatial accuracy, including depth of pipe. It has been a challenge for utilities to pinpoint the exact locations of service tees using current locating technologies on existing PE pipe in the ground.

Cofunders: OTD Members

Start Date: 2/1/2021
End Date: 10/3/2022
Status: Active
2020 Funds Expended: $15,000
Total Project Cost: $220,000
Total SCG Cost: $25,287
Total Cofunding: $194,713
Benefits:

Ambient NO2 Modeling for One-Hour Standard (CPS-11-5 & 5A)

SoCalGas worked with PRCI, Interstate Natural Gas Association of America Foundation, American Petroleum Institute, and other trade associations to build a robust emission data set that could be used to assess the performance of AERMOD, the US EPA's compliance tool for estimating impacts from air pollutant emission sources and to develop recommendations for the EPA to improve AERMOD and/or model inputs. To date, the publicly available dataset has proven valuable to other modelers, who have begun using it to assess other topics related to AERMOD performance and improvement. Analyses comparing the model to observed concentrations have been presented at EPA conferences. PRCI, SoCalGas, and consultants continue to work with EPA modeling staff to review analyses, prepare white papers and a final report, identify pathways to improve the model, and develop a methodology for improving model impact estimates from reciprocating engine sources.

Cofunders: PRCI Members, INGAA, INGAA Foundation, API

Start Date: 1/1/2014
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,172,696
Total SCG Cost: $354,310
Total Cofunding: $2,818,386
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Applying Heat to Steel Near PE (5.19.s)

This project intends to identify and validate the best practices of applying heat to steel near PE material. Field welding on steel pipeline components can transfer heat to adjoining PE material and affect its integrity. This study will consider all the possible worst-case scenarios, in the field, and the associated parameters to create a model that will allow the user to simulate field conditions and predict the risk of heat damage to plastic facilities. A preliminary simulation model has been developed. The next steps include continuing the simulation work, varying the model parameters, and performing validation testing.

Cofunders: OTD Members

Start Date: 10/3/2019
End Date: 11/3/2021
Status: Active
2020 Funds Expended: $50,250
Total Project Cost: $188,500
Total SCG Cost: $100,500
Total Cofunding: $88,000
Benefits:

Assessment of Methane Emission Quantification Techniques for Storage Facilities (US-4-2A)

This project identified new methane quantification technologies that have recently emerged and demonstrated the capabilities of selected technologies in an underground storage field environment. Results of this project provide operators with an overview of available technologies and their appropriateness for different applications. Two optical gas imaging systems were selected for testing and demonstration to validate their capabilities for methane emission detection and quantification. The final report has been published.

Cofunders: PRCI Members

Start Date: 7/1/2018
End Date: 12/14/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $123,900
Total SCG Cost: $9,197
Total Cofunding: $114,703
Benefits:

B31Q Training Documentation (8.20.a)

The objective of this project is to build and implement a prototype training documentation online portal for utilities to share training materials, such as videos, documents, and presentations leveraging expertise and resources. This project focuses on the training for PPQP as described in the ASME B31Q standard. ASME B31Q establishes the requirements for developing and implementing an effective PPQP. It specifies the requirements for identifying covered tasks that impact the safety or integrity of pipelines, for qualifying individuals to perform those tasks, and for managing the qualification of pipeline personnel. Software development has been completed. The next step is software testing.

Cofunders: OTD Members

Start Date: 1/1/2020
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $20,000
Total Project Cost: $258,000
Total SCG Cost: $40,000
Total Cofunding: $218,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Best Practices to Address Odor Fade in High-Rise, Low-Occupancy Buildings (5.17.d)

The goal is to develop best practices on how to odorize gas pipes in high-rise, low-occupancy buildings to prevent odor fade. Odor fade is a phenomenon that occurs in low-gas-flow situations due to odorant adsorption on rust particles inside the pipeline. Loss of odorant effectiveness in natural gas is a public safety concern. Odorant is an important safety barrier added to natural gas, which is odorless, to enable people to detect leaks based upon smell. During the project execution, it was determined that uncoated steel pipe should be included in the testing and analysis of odor fade. The testing will include pickling experiments.

Cofunders: OTD Members

Start Date: 4/17/2017
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $375,643
Total SCG Cost: $44,643
Total Cofunding: $331,000
Benefits:

Center for Hydrogen Safety

The purpose of CHS is to foster a global community around hydrogen safety. CHS was launched in April 2020 with the United States Department of Energy as a strategic partner along with the Hydrogen Council and California Fuel Cell Partnership. Adding hydrogen to natural gas can significantly reduce GHG emissions if the hydrogen is produced from renewable energy such as solar, wind, and other low-carbon energy sources. CHS supports and promotes the safe handling and use of hydrogen across industrial and consumer applications in the energy transition. A smaller Codes & Standards working group was formed focusing on H_2-NG blending in NG pipeline systems. Since the formation of this working group, members have discussed the current state of knowledge, existing knowledge gaps, and how CHS can help fill the knowledge gaps specifically related to hydrogen safety, such as safety zones.

Cofunders: JIP Members

Start Date: 11/1/2019
End Date: 11/1/2022
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $2,565,000
Total SCG Cost: $45,000
Total Cofunding: $2,520,000
Benefits:

Center for Methane Research (6.16.a)

CMR acts as a liaison between the natural gas industry, university researchers, government researchers, regulators, and other groups to ensure that important methane studies are made available while fostering collaborations. CMR will continue to disseminate technically accurate information to members, collect and analyze data on methane emission trends and atmospheric concentration levels, conduct new scientific investigations on the role of methane in global warming, and serve as a repository for this information. In 2020, two published studies were reviewed, identifying any errors or clarifications needed, and detailed summaries were prepared. A white paper was also written.

Cofunders: OTD Members

Start Date: 10/1/2016
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $25,000
Total Project Cost: $755,000
Total SCG Cost: $50,000
Total Cofunding: $705,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

CEPM for Turbochargers (CPS-14B-08)

The research project team is developing turbocharger performance models from data collected from a variety of past PRCI projects, as well as from new data collected at two compressor stations. The model will provide operators with early detection of decreased natural gas engine turbocharger performance, enabling them to schedule maintenance or repairs before the engine is unable to meet emission limits. Models have been developed that will be refined as more data is collected and validation testing is completed.

Cofunders: PRCI Members

Start Date: 1/31/2019
End Date: 5/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $102,101
Total SCG Cost: $8,653
Total Cofunding: $93,448
Benefits:

CFD Study of Prechamber Ignition Mechanisms for GHG Reduction (CPS-14-05)

This project represents the first phase of a multi-phase effort to understand PCC and MCC ignition performance characteristics and their impact on NOx and GHG emissions. The ultimate goals are to determine the relative importance of a variety of factors (e.g. temperature, chemistry, mixing) and to use that understanding to improve PCC system design and reduce emissions, most notably from natural gas engines that operate at extremely lean air/fuel ratios to achieve low NOx emissions. A final report has been issued correlating the variables' effect on emissions and providing a better understanding of how a PCC ignites the mixture of fuel and air in the MCC, what role the homogeneity of the fuel/air mixture plays, and how to make decisions about equipment upgrades based on the current condition of the engine and its supporting systems. Research indicated that better designed PCCs can dramatically reduce methane emissions in the exhaust, so a research road map was created. The next phase of this research will be performed under the Greenhouse Gases Emissions Reduction Strategic Research Priority as the Reciprocating Engine Exhaust Methane Slip Reduction (CPS-17-08) project.

Cofunders: OTD Members

Start Date: 12/10/2019
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $153,400
Total SCG Cost: $36,169
Total Cofunding: $117,231
Benefits:

Clothing Performance Guidelines to Reduce Heat Stress for Natural Gas Workers (5.18.r)

Improvements in worker safety and health are a top priority for the natural gas industry. Thermal comfort and heat stress are significant concerns for outdoor workers in the industry. PPE, such as fire-resistant clothing, must be worn while working in a flammable atmosphere. This PPE restricts heat dissipation away from the worker, especially in hot climate environmental conditions. There are currently no industry-wide requirements or standards to guide the selection of fire-resistant clothing to reduce heat strain for workers in hot and stressful working environments. In this study, the North Carolina State University team is focused on understanding the effects of heat strain and comfort as related to flash suits utilized by natural gas companies. The thermal resistance of two work uniforms, Flame Resistant, Non-Flame Resistant, and nine flash suits are currently being tested using a thermal manikin.

Cofunders: OTD Members

Start Date: 7/1/2018
End Date: 8/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $284,422
Total SCG Cost: $10,022
Total Cofunding: $274,400
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Development and Evaluation of High Resolution Historical Climate Dataset Over California (GFO-19-501, Group 2)

Weather forecasting models are used to determine utility infrastructure vulnerabilities in extreme weather events such as extremely dry conditions that pose wildlife dangers, and extremely wet conditions that can cause floods and mud slides. Two climate models are currently used for forecasting: West Weather Research and Forecasting Model for California "dry" simulations, and Desert Research Institute's Weather Research and Forecasting model for California "wet" simulations. The CEC's project Development of High Temporal and Geographical Resolution Characterization of Historical Climatic Conditions in California (CEC GFO-19-501, Group 2) awarded to UC San Diego/ Scripps Institution of Oceanography will assemble climate data from California between 1980 to 2019 to be used to improve both models for forecasting weather conditions. The goal is to provide models that will enable utilities to assess infrastructure risks associated with exposures to short-term and long-term extreme weather events.

Cofunders: CEC

Start Date: 6/30/2020
End Date: 3/31/2024
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,363,550
Total SCG Cost: $0
Total Cofunding: $1,363,550
Benefits:

Gas Imaging Technologies (7.16.b)

Being able to quickly measure and identify the source of a natural gas leak, methane plume size and its direction are very important, not only to the safety of customers, but also first responders. The project objective was to evaluate the use of OGI technologies for various applications in the gas industry. Specific applications included methane emissions quantification and leak investigation by first responders. Prior to 2020, a testing matrix was developed to determine the parameters and evaluation conditions for the OGI cameras and applied to the evaluation of two cameras for the leak detection use case. Criteria included: distance from the leak, leak rate, leak area, leak source, temperature, and other environmental conditions. An interim report was written summarizing data from the technology evaluation and recommendations were provided to the manufacturers. In 2020, an updated OGI camera was presented for evaluation of its quantification capabilities. Testing was completed in 2020 with the Final Report expected in 2021. This report will enable operators to determine if the use of OGI cameras is a viable option for identifying gas leaks and quantifying methane emissions.

Cofunders: OTD Members

Start Date: 2/1/2016
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $308,757
Total SCG Cost: $21,757
Total Cofunding: $287,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Gas Utility Threat Contextualization (Real-Time Visualization and Notification)

SoCalGas recognizes that it is essential to make fast, accurate, and informed decisions in an ever-changing environment. DataCapable is a patented machine-learning algorithm and 24/7 monitoring validation and contextualization platform that provides real-time awareness, perimeters, and geoanalytic capabilities related to threat mitigation and response. The following events were included in the pilot: wildfires, civil unrest, landslides, gas explosions, flooding, gas leaks, evacuations, and earthquakes. A three-month proof-of-concept pilot was completed to evaluate the DataCapable platform and to gain a deeper understanding of how it could augment existing workflows at SoCalGas, enhancing situational awareness of events that impact the safety of employees, customers, and the gas infrastructure. The Proof-of-Concept Pilot successfully integrated the platform's information into SoCalGas's GIS applications and the emergency response workflow. The platform demonstrated the ability to quickly react to changing conditions by providing a new use case within 24 hours upon request, supporting emerging use cases.

Cofunders: N/A

Start Date: 4/1/2020
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $50,000
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

Greenhouse Gases Emissions Reduction (SRP-GHG-01)

GHG emissions are a global issue that has a large impact on the natural gas industry. PRCI established this Strategic Research Priority (SRP) to coordinate the efforts across all of the technical committees. The SRP goal is to provide a roadmap of research projects to significantly reduce GHG emissions from the natural gas transmission system. This information will provide the natural gas industry with GHG reduction solutions to implement and reduce its carbon footprint. The SRP funded eight projects for 2021: Regulatory Support for GHG Emission Reductions (CPS-11-09), Continuous Monitoring and Diagnostics for Facility Efficiency (CPS-14-06), Fuel Reforming and Segregation as an Alternative for Compressor Fuel (CPS-14-07), Improvements in Facility Efficiency (CPS-17-07), Reciprocating Engine Exhaust Methane Slip Reduction (CPS-17-08), Methods to Reduce Pipeline Blowdowns to Effectuate Repairs/Inspections (MATR-3-15), Flow Sensors for Continuous Monitoring and Diagnostics for Equipment Efficiency Monitoring (MEAS-5-28), and Methane Leak Detection and Quantification (PL-1-08).

Cofunders: PRCI Members

Start Date: 01/01/2021
End Date: 12/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $4,670,735
Total SCG Cost: $31,208
Total Cofunding: $4,639,527
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Guidelines for Assessing Indoor Meter Set Relocation Risk (5.17.a)

The project objectives were to provide utilities with additional knowledge and a standardized risk-based assessment process regarding the placement and risks associated with indoor gas meter set assemblies and to evaluate the possibility of relocating the meter set outdoors or to other suitable locations. Utilities are frequently challenged to find suitable locations to place meter sets that will not pose a safety risk and that will balance concerns of both regulatory requirements and consumer demands. This project generated a useful, field-vetted meter set risk assessment form that utilities can use to track indoor meter set inspections and keep photo records of indoor meter sets as a method of risk management.

Cofunders: OTD Members

Start Date: 4/13/2017
End Date: 6/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $182,246
Total SCG Cost: $8,246
Total Cofunding: $174,000
Benefits:

Improved Catalyst Regeneration Process (CPS-13-01A)

Oxidation catalysts are effective at reducing CO, CH_2O, and some VOCs from the exhaust of natural gas engines used in transmission and underground storage facilities. A catalyst regenerator removes contaminants that reduce its performance. An optimal oxidation catalyst regeneration technique (washing) will be developed from previous work and evaluated on an exhaust slip stream in the laboratory. This washing technique will be shared with the natural gas industry. Small-scale tests on degraded catalyst samples will be performed to assess whether thermal treatment can be incorporated into the catalyst regeneration process to remove more catalyst poisons than chemical washing by itself. Catalyst samples will be processed by thermal treatment followed by chemical washing and vice versa. If more catalyst poison is removed with the new technique, it extends the life of the catalyst and decreases operating costs. The research contractor has completed the bench-scale test. The results show the new technique restores the oxidation catalyst's control efficiency. Next, the effectiveness of the regenerated catalyst in treating the exhaust from a compressor engine will be tested.

Cofunders: PRCI Members

Start Date: 1/1/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $41,300
Total SCG Cost: $20,650
Total Cofunding: $20,650
Benefits:

Improving HCA Classification Methods (8.21.f)

The objective of this project is to improve the accuracy of classifying high consequence areas and moderate consequence areas through modern data analysis and data sources. A high-consequence area is specifically defined as an area where a release of natural gas would adversely impact the health and safety of the affected population. The current methodology to define consequence areas is set by PHMSA. This methodology can use outdated data that does not consider the dynamic population patterns and development patterns near urban areas. The fluctuating variables can potentially change the impacted areas and expose the utility and general population to unnecessary risk. This project will explore the use of modern data sources and develop algorithms to automate the quantification of population or building use and size.

Cofunders: OTD Members

Start Date: 3/1/2021
End Date: 7/29/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $184,000
Total SCG Cost: $36,800
Total Cofunding: $147,200
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

In Service Welding Onto Methane/Hydrogen Mixture Pipelines (JIP)

The objective of this Joint Industry Project is to determine if welding onto an in-service pipeline that contains a mixture of methane and hydrogen results in an increased risk of hydrogen cracking in the weld seam. If the study identifies an increased risk, mitigation measures will be developed. The ability to safely make in-service welds on pipelines that transport a blend of hydrogen and methane will allow installation of pipeline components (i.e. full-encirclement repair sleeves and hot tap branch connections), while the pipeline remains in service, thus maintaining system reliability. In 2020, a proposed experimental matrix was developed and the pipe materials to be tested were identified.

Cofunders: JIP Members

Start Date: 5/14/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $255,000
Total SCG Cost: $30,000
Total Cofunding: $225,000
Benefits:

Intelligent Shutoff Device - Phase 3 (5.12.a.3)

Phase 3 developed field-ready prototypes of the intelligent shut-off device for natural gas service lines based on designs and constraints identified in earlier phases. Third-party damage is the main threat to below-ground natural gas distribution systems. The goal of this project was to minimize this risk by limiting the volume of gas released from such incidents. The Service Line Valve design comprises a coaxial piping configuration whereby the inner pipe supplies the gas and the outer pipe serves as the protective casing. If the outer casing sustains through-wall damage, the pressure in the annular space will drop, thus activating the Service Line Valve. Tangential to these underground damage protection features, a need was identified for an aboveground valve adjacent to the meter with additional safety sensing features. The Meter Valve is installed before the meter set and provides smart shut-off features activated from remote sensors that detect natural gas leaks, fires, earthquakes, flooding, or over-/under-pressurization events. Both valves are now available commercially for deployment, pilot studies, and/or internal testing. Further research will continue under a CEC project.

Cofunders: OTD Members

Start Date: 3/1/2017
End Date: 12/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $320,595
Total SCG Cost: $65,595
Total Cofunding: $255,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Isolation Valves Scoping Study to Reduce Through-Valve Gas Leakage (CPS-17-04)

The US EPA annual GHG inventory indicates that a primary source of natural gas reciprocating compressor leaks (emissions) results from unit isolation and blowdown through-valve leakage, which also poses safety concerns due to presence of gas in workspaces downstream of an isolated portion of the suction or discharge header system, where gas can accumulate. The identification, repair, or replacement of leaking compressor unit isolation valves can be very costly. Thus, cost-effective valve selection, maintenance, repair, and replacement options are needed. In 2019, the project team completed surveys and interviews with PRCI member companies. The results did not yield any meaningful correlation between leakage and valve design characteristics, but did result in recommendations for future projects exploring the improvement of measurement and detection techniques. SoCalGas expanded the project's data gathering surveys and interviews, identifying unique aspects of the SoCalGas facilities. Future projects stemming from this work will be funded under the SB1371 Leakage Abatement Program.

Cofunders: PRCI Members

Start Date: 2/15/2019
End Date: 3/31/2020
Status: Completed
2020 Funds Expended: $940
Total Project Cost: $81,661
Total SCG Cost: $41,661
Total Cofunding: $40,000
Benefits:

Itron Valve with Methane Sensor - Phase 2 (5.14.w.2)

This project was intended to evaluate the performance of a methane sensor integrated with a gas shut-off valve to provide gas operators with advanced indication of abnormal operating conditions that could result in a gas release inside a building. Since the technology providers identified for this project were no longer in alignment with the original project's objective, the project was put on-hold pending the identification of other technology collaborators or completion of a needs assessment. In 2020, it was decided to close out this project and incorporate this research with a new project involving smart gas shut-off technology for commercial and residential buildings.

Cofunders: OTD Members

Start Date: 12/1/2017
End Date: 11/29/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $141,153
Total SCG Cost: $1,653
Total Cofunding: $139,500
Benefits:

Natural Gas Emissions Detection & Quantification

The project team evaluated the results of a belowground pipeline leak centering method utilizing the Joule Thompson cooling effect. The idea was that the pressure drop experienced by the gas escaping at the leak point results in a subsequent temperature drop of the gas itself along with its immediate surroundings, which could be measured. Preliminary studies in the lab and field indicated there may be some promise to centering the location of an underground leak by identifying the barhole (ground opening to insert a probe into the soil) with the lowest soil temperature. However after collecting a larger field dataset it became clear that although the cooling effect of the leak may produce a noticeable temperature difference, it does not produce a large enough temperature drop to allow for the leak point to be differentiated from the natural temperature variations that exist from point to point within a typical field location. Based on these findings, the project will not be pursued further.

Cofunders: N/A

Start Date: 1/1/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $1,037
Total Project Cost: $350,571
Total SCG Cost: $350,571
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

ORFEUS Obstacle Detection Technology for Horizontal Directional Drilling (5.16.k.2)

The objective is to evaluate the ORFEUS obstacle detection technology, which utilizes forward-looking ground-penetrating radar built into the drill head of a horizontal directional drilling system. A majority of new underground installations of utility infrastructure is performed using this system, a trenchless process. Trenchless installations may cause unintended damage to other substructures due to the inability to detect obstacles in front of the drill path. The goal is to reduce the incidence of third-party damage to existing buried infrastructure by providing real-time early warnings to the drilling operator. Information obtained from this project will assist the technology developer in further enhancing the detection and communication capabilities of its technology. Contractual issues delayed the start of the project until January 2021.

Cofunders: OTD Members, PHMSA, Others

Start Date: 12/1/2017
End Date: 3/31/2022
Status: Active
2020 Funds Expended: $18,673
Total Project Cost: $4,286,446
Total SCG Cost: $62,346
Total Cofunding: $4,224,100
Benefits:

Performance, Durability, and Service Life of Residential Gas Regulators (5.18.n)

This project will determine the durability and expected service life of common pressure-reducing gas regulators used in residential meter set assemblies. The project consists of two phases. Phase I involved a study on regulators' reliability and failure modes. Phase II will build a test rig and perform life-cycle testing. Utilities will receive results and technical support for a better understanding of the expected service life of regulators. Phase I has been completed. A preliminary fault tree analysis and reliability assessment plan were completed for the regulators and the common failure modes, failure root causes, and regulators of interest were identified. The next step is to execute regulator endurance testing of at least 25,000 pressure cycles.

Cofunders: OTD Members

Start Date: 10/31/2018
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $295,000
Total SCG Cost: $3,865
Total Cofunding: $291,135
Benefits:

Remote Gas Sensing For First Responders - Phase 4 (7.15.b.4)

During natural gas leak investigations, first responders need the means to assess gas concentration in multiple areas, such as buildings, manholes, and outdoors. Knowing the simultaneous concentration at multiple locations, without the need to physically be present, will save time and improve safety. Prior research developed a methane detection system to enable a leak investigator to remotely monitor methane levels at multiple points within a site under investigation. The objectives of Phase 4 are to develop precommercial ready units that can be tested by utility members and to develop a wireless communication system to allow a leak investigator to remotely monitor methane levels, at multiple points, within a site under investigation.

Cofunders: OTD Members

Start Date: 9/1/2019
End Date: 10/31/2022
Status: Active
2020 Funds Expended: $13,500
Total Project Cost: $358,000
Total SCG Cost: $27,000
Total Cofunding: $331,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Residential Methane Detectors - Phase IV Placement Study (1.14.g.4)

The project performed a literature review and developed a scientifically sound rationale for recommendations on where to place commercially available RMDs inside a residence to enhance customer safety. Although these systems are commercially available, placement of these methane detectors can affect their performance in detecting natural gas leaks. The recommendation is that placement of RMDs should be in the vicinity of a potential leak source (i.e. natural gas appliances) and located about a foot from the ceiling. The findings of this project will be used to support the development of a new standard for methane detection systems in the National Fuel Gas Code led by GTI, International Codes Council, and the National Fire Protection Association.

Cofunders: OTD Members

Start Date: 11/1/2017
End Date: 1/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $91,893
Total SCG Cost: $5,893
Total Cofunding: $86,000
Benefits:

Residential Methane Detectors Program, Phase V: Improving LDC Customer Education (1.14.g.5)

A science-based evaluation of LDC gas safety literature was conducted using the lessons learned from a consumer behavior survey completed in a prior phase of the RMD program. The goal was to make technical recommendations on how to incorporate the use of RMDs in gas safety messaging. The primary source of consumer warning that a gas leak may be present is the use of gas odorants as a malodorous warning agent. While these warning agents as currently specified in pipeline safety codes are a solution to gas detection, additional consumer protection would be provided by advocating the use of appropriate residential gas detectors. The evaluation found that only a small percentage of utilities include information on residential methane detectors in their consumer messaging. Recommendations were that education campaigns should leverage aspects of Learn, Love and Fear, while avoiding motivations of Responsibility or Destruction to increase both adoption of residential methane detectors and reporting of gas leaks. The project provided suggested communications and messaging to incorporate for utilities not already communicating this information.

Cofunders: OTD Members

Start Date: 9/3/2018
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $69,000
Total SCG Cost: $972
Total Cofunding: $68,028
Benefits:

Selecting Locating and Excavation Technologies (5.20.b)

Third-party excavation damage to underground natural gas pipeline is a safety issue and a leading cause of property damage. The objective of this project is to develop a web-based program and database for end-users to assist in developing communication tools between excavators and pipeline operators for the selection of locating technologies and best practices for safe excavations of belowground assets. The results should reduce the risks of pipeline excavation damage and provide situational awareness of potential accidents. A web-based data management program has been developed for searching, processing, and displaying records of these incidents. Further analysis of this data is currently being performed.

Cofunders: OTD Members, PHMSA

Start Date: 9/30/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $10,000
Total Project Cost: $759,000
Total SCG Cost: $13,872
Total Cofunding: $745,128
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Smart Shutoff Technology for Commercial and Residential Buildings (5.20.k) (CEC GFO-19-502, group 2)

This project was awarded by the CEC to improve the safety and integrity of natural gas infrastructure. The objective is to provide the natural gas industry with the necessary hardware and software components to create a full-solution, smart shut-off system that can detect and terminate gas flow in response to a hazardous incident such as a fire, flood, or gas leak inside a residential or commercial structure. Currently, the natural gas systems lack access to cost-effective safety sensors and shut-off valves that communicate valve and smart sensor status and terminate the flow of gas after the detection of a hazardous incident. Deployment of smart shut-off systems can provide the localized detection and mitigation needed to prevent hazardous events from becoming excessively dangerous and costly.

Cofunders: OTD Members, CEC

Start Date: 8/4/2020
End Date: 8/4/2023
Status: Active
2020 Funds Expended: $5,194
Total Project Cost: $1,200,000
Total SCG Cost: $25,019
Total Cofunding: $1,174,981
Benefits:

Software Tool to Assess the Human Factors Risk of Pipeline damage during Pipeline Construction, Operations and Maintenance (DP-3-06)

To help companies understand the hazards and risks associated with their pipeline operations, the Pipeline Assessment Tool for Human Factors was developed. This tool is designed to identify the gap between actual company performance and desired performance on each of 25 top human factors issues identified. The project provided examples of when the tool will be most useful in the field to identify the human factors risks in construction, operations, and maintenance activities. The human factors cover areas such as: valves and safety equipment, pipeline signage, excavation practices, ground surveillance, public awareness, and ground patrols. The operator now has a tool to determine the gap between his/her system performance and the performance that is expected by good industry practices. A comparison between the actual and expected performance will identify areas that need to be addressed.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 1/27/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $52,200
Total SCG Cost: $8,000
Total Cofunding: $44,200
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Stanford Natural Gas Initiative

The Stanford Natural Gas Initiative (NGI) is a collaboration of more than 40 research groups at Stanford University drawn from engineering, science, policy, geopolitical, and business disciplines that works with a consortium of industry partners and other external stakeholders to generate the knowledge needed to use natural gas to its greatest social, economic, and environmental benefit. It focuses on creating innovative technologies for natural gas production from unconventional sources, alternatives to hydraulic fracking, and offshore methane hydrates. NGI organizes its research portfolio into seven focus areas and operates a seed grant program to encourage new work on natural gas by Stanford researchers and strategic funding to support important work that does not closely fit into any of our focus areas. In 2020, NGI published: two natural gas briefs, one white paper, two books, twelve research papers and conducted multiple seminars, dialogues, meetings, webinars, and workshops.

Cofunders: NGI Members

Start Date: 1/01/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $75,000
Total Project Cost: $1,795,000
Total SCG Cost: $225,000
Total Cofunding: $1,570,000
Benefits:

Study of Natural Gas Dispersion with Blended Hydrogen in Residential Structures (M2021-001)

The goal of this project is to map the dispersion of hydrogen, methane, and hydrogen-methane blends (6% and 20% hydrogen) in an experimental setting. Physical tests and computer simulations will be used in the study. All physical tests will be limited to 25% LEL concentration levels, and the Computational Fluid Dynamics modeling will use 60% LEL as the end point criterion. The primary objective of the modeling effort will be to compare the results of the blended fuels with the pure fuels to determine how the gas behavior is altered and how gas detection may be impacted by methane and/or hydrogen concentration. The test results from this project will help determine if hydrogen dispersion rates differ from those of natural gas if leakage were to occur, and if current gas detection practices are sufficient to protect the safety of utility customers.

Cofunders: NYSEARCH Members

Start Date: 1/31/2021
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $170,065
Total SCG Cost: $15,460
Total Cofunding: $154,605
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Subsurface Multi-Utility Asset Location Detection (5.20.a)

This project builds on the success of the past development efforts and continues to test, complete field trials of, and commercialize a continuously locatable on-pipe electronic marking system for PE pipe. Accurate location of buried PE pipe reduces the risk of third-party excavation damage. The objective is to develop and demonstrate an on-pipe electronic marking system that uses discrete RFID markers to highlight and identify points of interest, whose locating accuracy will be enhanced by a high-accuracy GPS locating system. This is an alternative to using traditional locating wire, which is susceptible to physical and corrosion damage, making them inoperable. The markers will be integrated into the PE pipe during the manufacturing process. Operators can use the system to document the location of subsurface plastic pipes, provide accurate GPS coordinates for pipe and points of interest, and assign a quality score to the location data that is transferred to an operator's GIS. In 2020, a pipeline extrusion partner was secured and the marker attachment method in a manufacturing environment was determined.

Cofunders: OTD Members, PHMSA, Others

Start Date: 12/1/2019
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $25,000
Total Project Cost: $2,094,494
Total SCG Cost: $29,715
Total Cofunding: $2,064,779
Benefits:

Virtual Reality (VR) Training: Emergency Response Situations (5.18.t)

The project developed a realistic and interactive computer-generated VR training module for Natural Gas Emergency Response Situations. VR has one of the highest retention rates of all teaching styles as an adult-learning technique. This training module included over 66,000 random scenarios related to responding to a natural gas leak that migrated into the main sewer line resulting from third-party damage to a gas line causing the uncontrollable release of gas. In 2020, the module was customized to align with SoCalGas' company policies. The developed module is being evaluated for the best approach to integrate the technology into the training curriculum at SoCalGas' Training Facility.

Cofunders: OTD Members

Start Date: 7/1/2018
End Date: 11/30/2020
Status: Completed
2020 Funds Expended: $30,000
Total Project Cost: $360,246
Total SCG Cost: $60,397
Total Cofunding: $299,849
Benefits:

Virtual Reality Training Library Development (5.18.t.2&3)

The goal is to develop a VR content library and delivery system that utilities can use to assist in the training of their personnel on operations and maintenance procedures. This project will develop and use realistic, interactive, and immersive VR training modules that will provide utilities several operational advantages and provide guidance on how to deploy them. VR technology will be evaluated to determine if new developments can enhance the VR training experience. The use of VR modules will improve learner retention, improve consistency of training delivered, allow training to be conducted on demand by operations, increase the number of real-life training scenarios available for trainees to experience, and reduce the risk of injury to trainees. Five modules have been developed and are currently being tested by sponsors: Appliance Inspection, Inside Leak Investigation, Outside Leak Investigation and Classification, Facility Locating and Marking, and Pipeline Patrolling.

Cofunders: OTD Members

Start Date: 11/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $735,500
Total SCG Cost: $75,000
Total Cofunding: $660,500
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: OPERATIONS TECHNOLOGIES

3D Visualization Software for Mapping Underground Pipelines and Improving Pipeline Asset Management (8.20.m) (CEC GFO-19-502, group 4)

Inaccurate or insufficient locating practices for buried infrastructure are associated with a significant amount of third-party damage. Knowing the location of buried infrastructure can significantly aid in mitigating these risks and preventing damage. In this CEC co-funded project, GTI will develop 3D visualization software for mapping underground pipelines and improving pipeline asset management. GTI's solution aggregates several existing and proven technologies assembled into one Locate Technology Platform to support the implementation and adoption of new business processes designed to achieve operational performance improvements. This solution creates a set of business process models that an organization may implement to improve the geospatial accuracy of existing GIS data in both the horizontal and vertical dimensions. This platform assists the field users in visualizing infrastructure location data from a variety of viewpoints. Once the Locate Technology Platform is completed, it will be validated in a field demonstration.

Cofunders: OTD Members, CEC

Start Date: 6/30/2020
End Date: 7/31/2023
Status: Active
2020 Funds Expended: $25,000
Total Project Cost: $2,084,436
Total SCG Cost: $85,000
Total Cofunding: $1,999,436
Benefits:

Automation of the Explorer Series of Robotic Platforms Phase I, II, II-a, III (M2017-002)

A range of robotic inline inspection platforms used for unpiggable pipelines, called Explorer, is currently being deployed by service providers for the gas pipeline operators. The project objectives are to reduce the operational complexity of deploying the Explorer robotic platforms inside the pipeline and increase their overall capability by automating operation/control functions. This research is currently in Phase III. Phase I evaluated the automation potential of the existing hardware and identified required modifications. Phase II implemented software and hardware modifications to enable upstream feature recognition, pipeline mapping capabilities, and autonomous control scripts for simple maneuvers. Phase III focuses on refinements needed to adapt the system for commercialization. Development of control modules and components is currently on-going.

Cofunders: NYSEARCH Members, Invodane

Start Date: 2/28/2017
End Date: 10/31/2021
Status: Active
2020 Funds Expended: $125,875
Total Project Cost: $4,212,620
Total SCG Cost: $232,255
Total Cofunding: $3,980,365
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Composite Repair Wrap for PE – Phase 2 (2.14.a.2)

Mechanically damaged PE piping is typically repaired by removing and replacing the damaged section. However, this can be costly and may require installing gas bypass piping to preclude disruption of gas service to customers. Options that currently exist for the in-service repair of damaged pipes are few, costly, and not universally accepted. The project's goal is to evaluate a structural reinforcing system for the in-situ repair of damaged in-service PE pipe. The repair method consists of applying a composite reinforcement wrap over the damaged area and applying heat for curing. A practical PE permanent repair system will save time and money while minimizing service disruptions. This project has experienced several equipment issues with the Cycle Pressure Fatigue test rig, which has delayed testing. Currently, GTI is troubleshooting and modifying the Cycle Pressure Fatigue test rig.

Cofunders: OTD Members

Start Date: 5/7/2018
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $75,900
Total SCG Cost: $8,576
Total Cofunding: $67,324
Benefits:

Continuation of Single-Path Ultrasonic Meter Long Term Performance Testing and Monitoring (5.20.e.2)

The objective of this project is to build upon the research accomplished in the previous phase by adding a residential diaphragm smart gas meter to the accuracy evaluation. The diaphragm gas meter passed the Initial Accuracy Test (ANSI B109.1_3.3.1), the Meter Capacity Test (ANSI B109.1_3.2.1), and the Low Flow Accuracy Test (AGA XQ1703_3.3.3). Currently GTI is working on the final analysis of the electronic testing. A comparative performance evaluation will be performed between the two ultrasonic meters and one diaphragm meter. This project will also evaluate the effectiveness of the smart gas meter shut-off valve and the communication capabilities of all three meters.

Cofunders: OTD Members

Start Date: 12/2/2020
End Date: 3/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $129,000
Total SCG Cost: $7,000
Total Cofunding: $122,000
Benefits:

Enhanced Locating Technologies for Underground Pipelines with Better Accuracy (8.20.I) (CEC GFO-19-502, group 3)

The objective of this CEC-cofunded project is to improve the safety and integrity of underground natural gas pipelines by increasing the accuracy and availability of horizontal and vertical pipeline location information. The approach is based on enhancing and adapting aboveground, large standoff 3D electromagnetic detection technology to locate buried pipelines and supplementing the technology with an in-pipe mechanism to focus on congested areas and plastic materials. SoCalGas will participate, focusing on transmission infrastructure. PG&E will focus on infrastructure in congested urban areas. SoCalGas is currently planning the logistics for field measurements. Improved tools are intended to provide access to three-dimensional data in near-real time, and the combined solution is anticipated to apply to most in-field conditions, including varying pipeline material, depth, and surface cover.

Cofunders: OTD Members, CEC, Other

Start Date: 11/4/2020
End Date: 11/30/2023
Status: Active
2020 Funds Expended: $5,000
Total Project Cost: $2,218,689
Total SCG Cost: $22,554
Total Cofunding: $2,196,135
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Evaluation of Methane Detection Technologies with Hydrogen-Methane Blends (Phase 1 & 2)

This is a two-phase project that will evaluate currently deployed methane leak detection technologies and new hydrogen-methane-blend-specific leak detection technologies. These technologies include: infrared absorption detectors, thermal conductivity sensors, flame ionization detectors, catalytic sensors, semiconductor sensors, and electrochemical sensors. Hydrogen-methane blends with 1%, 5%, 10%, and 20% hydrogen will be used for each evaluation to simulate potential pipeline blend compositions. Project results will be used to characterize the response and operation of the leak detection technologies for hydrogen-methane blend leaks and determine the devices that best detect hydrogen-methane mixtures.

Cofunders: N/A

Start Date: 6/1/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $10,090
Total Project Cost: $120,200
Total SCG Cost: $120,200
Total Cofunding: $0
Benefits:

Feasibility Study of Piggable Plug Technology for Onshore Gas Pipeline Inline Pressure Isolation (PLUG-1-01)

Piggable plugs can shut off gas flow and isolate a pipe segment for hydrotesting where local isolation valves are not available or other pressure control methods are costly. The project goal was to determine the integrity of onshore pipelines that can be affected by pig-like devices. The project tested the performance of different plug sizes at full scale and developed an Excel-Calculator for preliminary maximum stress estimation using parametric FEA results. Models and testing demonstrated that the highest stresses occurred where the tool made contact and that stress levels were low enough to isolate a pressurized section of pipe of specific wall thickness and grade without causing permanent plastic deformation. These tools should enable safe, expedient, and cost-effective pipeline repair, maintenance, and strength tests. They could also provide the option to install a pressure control fitting for maintenance work, an idea still under development, or be able to perform follow-on work on pipes with helical or longitudinal seams. The Final Report was delivered and SoCalGas is reviewing to determine use cases where this might be applied. This project was remapped from the System Design & Materials subprogram.

Cofunders: PRCI Members

Start Date: 2/1/2018
End Date: 4/13/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $354,000
Total SCG Cost: $11,756
Total Cofunding: $342,244
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GIS Portal Data Quality Improvement

The project objective is to test and evaluate a range of tools, and then recommend the most appropriate set of tools for Gas Distribution field personnel to capture the location of pipeline facilities using a combination of hardware (e.g., GPS, tablet, underground pipe locator) and GIS software. This project enables RTK-corrected and highly accurate GPS data to be captured by field employees performing routine activities. The project intends to implement a streamlined field-captured GPS data workflow into Enterprise GIS and aims to create a method that will lead to higher-accuracy positional data. SoCalGas will use this technology to test the accuracy of positional data from locating devices and compare these data to non-RTK-corrected data. The expected project benefits are an improved method to capture field data and transfer them to the mapping system, which will decrease the amount of time it takes to perform the task.

Cofunders: N/A

Start Date: 6/1/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $60,000
Total Project Cost: $60,000
Total SCG Cost: $60,000
Total Cofunding: $0
Benefits:

Guidance on the Excavation and Backfill Procedures in Areas of Geohazards and High Axial Stresses and Strains (SBD-1-5)

The project objective is to provide guidance on the excavation and backfill procedures in geohazard areas that can subject buried pipelines to high axial stresses and strains. The intended benefits are to reduce the risk of pipeline damage during mitigation work and increase worker safety. Operating heavy equipment in certain geohazards areas, such as landslides and settlement, requires extra caution. There can be concerns about the safety of the field crew and disturbances to pipeline support. Unnecessary restrictions and ineffective precautionary measures will be identified and excluded from the guidance document to save time, reduce cost, and minimize service interruptions. A draft report has been distributed for committee review and comment.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $236,000
Total SCG Cost: $9,797
Total Cofunding: $226,203
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

In-situ Ultrasonic Meter Flow Validation for Gas Meters (MEAS-6-17A)

The project objectives were to optimize the gas tracer method for field proving of ultrasonic flow meters and to illustrate the practical uncertainty of the method. The two primary benefits from this project included: 1) reduced measurement uncertainty and, therefore, reduced LAUF gas, and 2) reduced maintenance and operating costs resulting from less frequent meter recalibrations. This project provided a proof of concept for an in-situ verification method for ultrasonic flow meters in natural gas service. The tested method consisted of simultaneously injecting helium at a minimum of two locations upstream from an ultrasonic flow meter at a known distance apart. The results from this project showed the flow verification method was successful in determining gas velocity through an ultrasonic flow meter to within ±5% of the true value. These results indicated that the tested in-situ verification method was not accurate enough to replace a laboratory flow calibration, but could be used as a field diagnostic tool for maintenance and reduce operating costs resulting from less frequent meter recalibrations. A draft final report has been issued to project sponsors for review.

Cofunders: PRCI Members

Start Date: 11/1/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $106,200
Total SCG Cost: $4,396
Total Cofunding: $101,804
Benefits:

JIP PE Systems Research Program – Phases 1 and 2 (5.16.r, 5.16.r.2)

This JIP assembles parties within the gas industry to identify and address issues with the manufacturing, installation, and maintenance of PE piping systems. The JIP identifies necessary research needs, design, standards, and guidelines to enhance the overall integrity of PE materials for gas distribution systems. Phase 2 of this program continues with the same scope with a new steering committee. Two JIP meetings were held in 2020 to discuss the current ASTM International standards, Plastic Pipe Institute fusion procedures, nondestructive examination technologies, and hydrocarbon permeation to assess gaps in PE piping integrity programs at utilities.

Cofunders: OTD Members, JIP Members

Start Date: 10/1/2016
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $455,100
Total SCG Cost: $70,000
Total Cofunding: $385,100
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

OIML Test Data Summary for New Generation Ultra Sonic Meters (MEAS-6-21)

For many years, PRCI member companies have had interest in the effect of upstream piping configurations on ultrasonic meter performance. Many manufacturers have conducted testing based on OIML R137-1 because the documentation for their flow meters often cites conformance with this standard. However, these data have generally only been available by special request and typically are not presented in a way that allows for direct comparisons of meter performance. This project organized and compared non-public-domain data from different ultrasonic meter manufacturers' OIML R-137-1 testing programs for current multipath wetted model ultrasonic meters. Three manufacturers supplied OIML R137-1-compliant data sets. The data that were provided were valid and useful for determining the meter performance relative to various upstream piping configurations. As a result, the data presented in this report are applicable for determining the potential meter error for various combinations of upstream piping disturbances, flow meters, and upstream straight piping lengths both with and without flow conditioning. Currently, the final report is being prepared for the project.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $59,000
Total SCG Cost: $4,726
Total Cofunding: $54,274
Benefits:

Operation & Maintenance Technologies

This project area seeks to develop and deploy new technologies that improve the efficiency of inspecting, operating, maintaining, and rehabilitating gas pipeline infrastructure and to ensure that these systems continue to provide safe and reliable service. New technologies recently evaluated were a new OIT instrument and a PE fusion data logger. The OIT instrument used to measure the odorant levels in natural gas pipelines has been discontinued by the manufacturer. Two replacement OIT make/models were evaluated. One of the instruments passed all SoCalGas' performance criteria and has been approved for use in the company. A data logger designed to capture important PE fusion information was demonstrated by the manufacturer through a virtual meeting. This instrument will add improved traceability and a higher level of assurance that PE pipe and fittings were fused properly before they are placed into service. The company is currently evaluating the data logger capabilities.

Cofunders: N/A

Start Date: 6/1/2013
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $10,086
Total Project Cost: $50,963
Total SCG Cost: $50,963
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Portable Analyzer Lab Tests to Support Simplified Test Method (CPS-11-6B)

This PRCI project developed new practical, simplified, and cost-effective electrochemical portable analyzer emission test methods that will reduce emissions testing costs for reciprocating engines and turbines, including compliance test costs for state regulations and permits. These methods have been accepted by the US EPA as alternative test methods. In August 2020, the EPA posted the two methods as OTM-038 (Periodic Monitoring) and OTM-039 (Compliance). Permit holders and state agencies can reference those methods for periodic monitoring and compliance tests, thereby avoiding the existing, more complicated and more costly reference method tests. The work in 2020 included final discussions with the EPA and revisions of the OTM methods. A workshop is planned for 2021 to provide a procedural introduction of the new methods to operators, engineers, and technical stakeholders.

Cofunders: PRCI Members

Start Date: 10/1/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $102,200
Total SCG Cost: $5,000
Total Cofunding: $97,200
Benefits:

Protect Tracer Wires from Corrosion (5.17.k)

Tracer wire is installed next to PE pipe during construction to enable gas utility workers to locate buried pipeline for maintenance work. An electrical signal is transmitted through the tracer wire and can be detected aboveground with a pipe locator. However, the wire is susceptible to corrosion damage if its protective coating is damaged or at connections if the wire is exposed, rendering it inoperable. The project sought to develop methods/best practices to better protect tracer wire. The team took a multi-phased approach to analyze advancements in tracer wire systems to produce a report. First, the project team reviewed literature to establish a benchmark on industry practices and procedures. Next, the team surveyed project sponsors for best practices, compiled and summarized results, and compared them to the 2008 AGA Industry Survey in order to analyze the industry state of the art for tracer wire systems and recommended practices. Some commercial wire connectors were lab-tested to assess their ability to protect bare copper wire from corrosion. A Recommended Best Practices Report was provided to sponsors. SoCalGas company standards were reviewed to ensure that they met these findings.

Cofunders: OTD Members

Start Date: 8/17/2017
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $188,273
Total SCG Cost: $21,573
Total Cofunding: $166,700
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Small PE Diameter Squeeze-Off – Phase 2 (2.14.c.2)

Pressure control on PE pipe is performed using tools that safely squeeze the pipe to shut off the flow of gas. This project investigated, for small diameter (≤ 3") PE pipe, the minimum squeeze-off distances from fittings and other appurtenances that would not cause integrity issues at the joint. The objective was to develop and experimentally validate a model for predicting the effects of squeeze-off as a function of pipe diameter, temperature, and squeeze-point location relative to fittings and other appurtenances. Phase 2 investigated PE pipe that was not tested in Phase 1 of the project. The team determined that medium-density PE (Phase 1) and high-density PE (Phase 2) pipes squeezed near various fitting types at a minimum distance of three pipe diameters (3 times the outer diameter) did not cause integrity issues for smaller-diameter PE pipes. Study findings resulted in recommended changes to existing industry standards with potential efficiency and economic benefits for O&M activities. SoCalGas company standards were reviewed to ensure that they met these findings. This project was re-mapped from the System Design & Materials subprogram.

Cofunders: OTD Members

Start Date: 9/1/2017
End Date: 9/17/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $315,038
Total SCG Cost: $40,838
Total Cofunding: $274,200
Benefits:

Technology Testing Assessment Facilities

Utilities are frequently challenged to find tools or technologies to increase safety, lower operations and maintenance costs, improve accuracy, and/or replace existing equipment and/or tools that are no longer available. SoCalGas test facilities have been constructed to simulate portions of the company's operating system. This enables evaluation of new tools or technologies without impacting actual system operations or customers. For this project, team members will evaluate new technologies, tools, and/or equipment at the SoCalGas Gas Meter Test Rack or at Situation City. Technology performance that passes the minimum requirements may be approved and deployed in company operations. Currently, the Measurement Technology Group is evaluating the functionality and reliability of a residential ultrasonic gas meter and an advanced metering infrastructure network.

Cofunders: N/A

Start Date: 1/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $2,000
Total Project Cost: $114,300
Total SCG Cost: $114,300
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Uniform Frequency Code (5.18.m)

The objective of this project is to create an industry standard, guideline, or best practice uniform frequency code for RFID devices used to locate buried utilities. This code would establish a consistent frequency setting for RFID devices based on their respective utility designation, such as gas, electric, or water. A uniform frequency code proposal was presented to the CGA Best Practices Committee, and a Task Committee was formed to review and modify the proposal. In November 2019, an official Best Practice Electronic Markers Working Group team was created to develop the electronic markers best practice consensus language. The proposed language has been submitted for review and comment. Next, the project team will facilitate any procedural activities required to integrate the approved proposals into the next CGA Best Practices version.

Cofunders: OTD Members

Start Date: 7/1/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $135,000
Total SCG Cost: $5,322
Total Cofunding: $129,678
Benefits:

Update ASTM Standard on Soil Compaction Control Using the DCP (5.20.o)

The objective of this project is to work with the ASTM committee to review and update ASTM standard D7380-15 (Test Method for Soil Compaction Determination at Shallow Depths Using 5-lb DCP) for its required seven-year renewal. The DCP was established as an alternative to costly soil compaction density measuring methods. The existing ASTM standard was established in 2008 and renewed in 2015 to standardize the manufacture of DCP devices and the procedure used for soil compaction verification. SoCalGas and many other utilities continue to use the DCP as part of their daily excavation restoration operations. The ASTM committee will review the standard for relevance and compliance with ASTM D-18 standards, and the standard will be updated as needed based on committee feedback. The next step is to attend the ASTM virtual meeting and initiate the standard update document for the ASTM D18 committee approval.

Cofunders: OTD Members

Start Date: 12/1/2020
End Date: 11/30/2021
Status: Active
2020 Funds Expended: $4,000
Total Project Cost: $26,000
Total SCG Cost: $4,000
Total Cofunding: $22,000
Benefits:

Update of PRCI Pipeline Repair Manual (MATR-3-1A)

Technology advancements in materials, techniques, new products, procedures, etc. offer pipeline companies the opportunity to extend the life of assets in place. A comprehensive Pipeline Repair Manual is needed to document these new advances and provide engineering guidance to choose appropriate repair techniques for specific defects in pipelines. PRCI's Pipeline Repair Manual is widely used by the natural gas industry. The sixth edition manual has not been updated or revised since 2006. In the 14 years since the last revision, many codes have been changed and new codes have been passed that govern pipeline repairs. In addition, new, advanced repair technologies and techniques that are available today are not covered in the current manual. This project will update the manual by incorporating updated codes, new codes, and current techniques and technologies for repairing pipelines.

Cofunders: PRCI Members

Start Date: 6/30/2020
End Date: 12/30/2021
Status: Active
2020 Funds Expended: $4,609
Total Project Cost: $177,000
Total SCG Cost: $13,827
Total Cofunding: $163,173
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: SYSTEM DESIGN & MATERIALS

Aldyl-A Mains Failure Rate Analysis

The project's objective was to determine the contributing factors causing Aldyl-A PE gas main leaks. This was accomplished by identifying and understanding the relationships of external data sources that are appropriate for Aldyl-A analysis to identify the causes of leaks. The data explored included, but was not limited to: leakage data, vegetation condition, soil type, system pressure, temperature, and weather patterns. This analysis will help determine failure rates and inform the probability of failure for risk assessment and mitigation planning. The project was completed and the feasibility of implementing the results is being evaluated.

Cofunders: N/A

Start Date: 6/30/2019
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $74,939
Total SCG Cost: $74,939
Total Cofunding: $0
Benefits:

Alternative Caps for PE Service Tees (5.16.b)

The objective of this project is to develop an alternative cap design for PE tapping tees. The alternate cap design enables the PE cap to be fused on the tapping tee tower rather than having a cap that threads onto the tapping tee tower. A threaded cap has more potential for leakage due to inadequate O-ring seal engagement. A fused cap on a tee therefore decreases the risks of leakage. The participating manufacturer for the project has designed and developed a fusion cap and tapping tee assembly. The new design developed has some limitations, which will be discussed and addressed with a webinar for the sponsors and the manufacturer.

Cofunders: OTD Members

Start Date: 2/15/2016
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $112,400
Total SCG Cost: $32,115
Total Cofunding: $80,285
Benefits:

Applicability of Existng Metal-Loss Criteria for Low Hardening Steels (EC-2-8)

This two-year project evaluated the applicability of ASME B31G and Modified B31G corrosion assessment criteria for low-hardened steel pipe. These criteria were originally developed for high-hardened steel in lower strength grades and in older steel production. Using the assessment criteria, this project showed a change in pipe properties over time from quantifying the role of the flow response, the influence of strain hardening on failure response, and predicted failure pressure for metal loss defects in pipelines. The results provided insight into the possible role of mechanical properties of steel pipe in applications involving low-hardened steel. The Final Report was published and the study's findings will be used in future research projects.

Cofunders: PRCI Members

Start Date: 2/28/2018
End Date: 2/3/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $283,200
Total SCG Cost: $12,588
Total Cofunding: $270,612
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

ARPA-E REPAIR Program (TTSP)

Old cast iron, wrought iron, and bare steel natural gas distribution pipes make up 3% of utility pipes in use, but account for a disproportionate number of gas leaks and pipe failures compared to newer steel pipe. The ARPA-E REPAIR program seeks to reduce natural gas leaks from these pipes by developing a suite of technologies to enable the automated construction of new pipe inside existing pipe. REPAIR will advance the state of gas distribution pipelines by incorporating smart functionality into structural coating materials and developing new integrity/inspection tools. It will also create three-dimensional maps that integrate natural gas pipelines and adjacent underground infrastructure geospatial information with integrity, leak, and coating deposition data. SoCalGas involvement with the project is through the Testing and Technical Specification and Steering Panel Committee.

Cofunders: N/A

Start Date: 10/1/2020
End Date: 10/1/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $32,554,637
Total SCG Cost: $0
Total Cofunding: $0
Benefits:

Auto Diagnostic for Ultrasonic Flow Meter (MEAS-6-20C)

This project will develop a process and software to evaluate if changes in ultrasonic meter flow-related diagnostics (e.g. profile factor, asymmetry, and swirl) are causing a significant change in the estimated installed measurement uncertainty of the ultrasonic meter station. AGA currently requires that additional uncertainty due to installation effects be less than +/- 0.3%. The new software diagnostics tool incorporating AI and Knowledge Base information will enable gas operators to quantify system imbalances in near-real time, thereby reducing lost and unaccounted-for gas volumes, in conjunction with pipeline gas inventory calculations. The research results will be the development of a new software diagnostics tool for users. The contractor is completing upgrades to the software diagnostics tool, which will be made available to project sponsors in early 2021.

Cofunders: PRCI Members

Start Date: 3/1/2019
End Date: 3/3/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $118,000
Total SCG Cost: $3,819
Total Cofunding: $114,181
Benefits:

Biomethane Justification Study for Improved/Accepted Gas Quality Standards (7.18.b)

Biomethane derived from landfills, wastewater treatment plants, dairy farms, food waste processors, and other RNG sources is poised to become an increasing part of the natural gas equation, if fears surrounding biomethane injection can be reduced. This project will help set universally established gas quality acceptance standards for biomethane. The resulting knowledge of the risks will increase acceptance. As opportunities for biomethane injection into a distribution or transmission pipeline arise, considerations and requirements regarding safety, reliability, interchangeability, and continuity are needed to keep gas flowing and avoid service interruption. A risk assessment calculator has been developed that takes user-input data on concentrations of RNG/biomethane gas constituents found in a gas stream and provides a risk category of the impact to pipeline infrastructure materials. The draft final report has been issued for review and comment by project sponsors.

Cofunders: OTD Members

Start Date: 3/1/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $300,000
Total SCG Cost: $57,508
Total Cofunding: $242,492
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Blending Modeling (Hydrogen)

Hydrogen is considered an important energy carrier in the future for sustainable, reliable, and cost-effective energy. As an energy carrier, hydrogen will help secure the energy supply by utilizing locally available renewable energy resources such as wind, solar, and biogas. Hydrogen also contributes to a reduction of carbon dioxide emissions and air quality improvement by replacing fossil fuels with hydrogen produced from renewable energies. This project will determine the impact of blending hydrogen or off-spec RNG into SoCalGas pipelines and facilities. The concerns that will be addressed are: the distance and time for injecting blended hydrogen or off-spec RNG to be fully mixed, blending station designs, placement of monitoring equipment, and concentration of hydrogen on the internal pipe surface. CFD models will be developed to simulate various scenarios to determine their impacts. This project has been delayed due to the COVID-19 pandemic and resource turnover. Planning for the CFD models has been started.

Cofunders: N/A

Start Date: 12/20/2019
End Date: 12/20/2021
Status: Active
2020 Funds Expended: $2,132
Total Project Cost: $149,536
Total SCG Cost: $149,536
Total Cofunding: $0
Benefits:

California State University Senior Design Project 2019-2020

SoCalGas is working to quantify fugitive methane emissions from its buried facilities. One method uses an aboveground Hi-Flow Sampler in conjunction with a portable enclosure to capture and quantify methane emissions. The existing enclosure consists of a bulky, hard-to-transport 4'x4' frame made from PVC pipes. Senior engineering students at CSULA were tasked to redesign the enclosure to improve its portability and, thus, the efficiency of taking surface flux rate measurements. The students developed and modeled various collapsible enclosure designs in SolidWorks, utilized CFD to evaluate their performance, built Alpha prototypes of the two top simulated performers, and evaluated their real-world performance in the SoCalGas lab. The best-performing design was selected for Beta prototype building and testing. Unfortunately, due to the COVID-19 pandemic this task was cancelled. Despite this, SoCalGas is evaluating some of the Alpha design elements for incorporation into existing design modifications. Most notably, the students identified a cover material for the enclosure that SoCalGas will adopt, as the elasticity of the material makes it more resistant to tears than the current tarp material.

Cofunders: N/A

Start Date: 8/30/2019
End Date: 6/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Cathodic Protection Design Considerations for Facilities with Congested Areas (EC-6-10)

This project presented a computational approach to model current distribution for buried assets in congested areas. The approach developed a finite-element-based model for a facility and used the model to calculate the DC current distributions to various below-ground metallic assets. Two separate congested area facilities were modeled by using a storage tank terminal and a gas compressor station. The most important takeaways from this project are the following: 1) CP models for various types of congested area facilities can be developed, even for large and complicated facilities such as gas compressor stations with several compressor units, and 2) the CP models can also be used to design anode placement that will help optimize CP current to essential assets and minimize the diversion of CP current to the passive assets. Overall, implementation of the modeling approach to design and upgrade CP systems at the congested area facilities will help improve station operations, reduce CP maintenance costs, and improve safety by ensuring sufficient CP current to essential assets. The results are being evaluated for potential implementation.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 6/26/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $153,400
Total SCG Cost: $5,000
Total Cofunding: $148,400
Benefits:

CLSM to Manage Axial Soil Loads on Buried Pipelines

Ground displacements may produce pipeline strains well in excess of the levels produced under normal operating conditions. These excess loads are caused by movement of the pipe relative to the soil, as the pipe restricts the movement of the soil. The project's objective is to investigate the use of CLSM placed around a pipeline to reduce the axial loads caused by soil friction, and to avoid transferring these large axial loads to vulnerable in-line pipeline components, such as elbows, tees, service connections, etc. The use of CLSM could significantly reduce the need for costly mitigative measures to repair or replace damaged sections of pipeline due to ground displacement events. This project will investigate the effectiveness of using CLMS to prevent pipeline damage from soil friction loads.

Cofunders: PG&E

Start Date: 9/1/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $110,000
Total SCG Cost: $55,000
Total Cofunding: $55,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Deliver Comprehensive Metal-Loss Assessment Criterion (EC-2-10)

This project integrates and builds on work successfully completed in prior research, which developed a criterion for metal-loss assessment demonstrated in an independent evaluation to significantly reduce the scatter and address bias in contrast to ASME B31G and Modified B31G. The project intends to develop a Level 1 and Level 2 metal-loss assessment criterion that is easy to use and covers all pipe grades and construction era. The metal-loss assessment criterion will indicate the risk of leak and rupture, reduce inspection data scatter, and eliminate maintenance that does not affect risk reduction. The outcome of this effort will enable full-scale representative assessments of failure pressure in areas of corrosion damage that will have less scatter and conservatism than currently exist in ASME B31G, Modified B31G, and other assessment models, without compromising pipeline operational safety.

Cofunders: PRCI Members

Start Date: 4/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,587,263
Total SCG Cost: $126,423
Total Cofunding: $1,460,840
Benefits:

Development of Rational Ovality Limits (CNST-3-1)

This project developed rational and consistent pipeline ovality limits for steel pipelines before they are placed in-service. Ovality of the pipe cross section can form during pipeline construction. The acceptance of such ovality is governed by industry standards, such as CSA Z662, or company specifications. Those ovality limits are found to be inadequate or can be overly restrictive for some pipes, which are limited to 5% for nominally straight pipes. Pipe with ovality exceeding 5% is automatically replaced and the pipe does not need engineering assessment. Testing found that under static conditions, pipe failure due to high levels of ovality was unlikely but found that high levels of ovality caused collapse of the pipe under external loads. Also, an ovality formed without internal pressure re-rounded significantly when moderate pressure levels were applied, but pipe deformation before re-rounding led to plastic strain at moderate levels of ovality (e.g., 5 – 6%). These results allow pipeline operators to reject or accept ovalized pipes of various dimensions and strengths with a consistent margin of safety.

Cofunders: PRCI Members

Start Date: 1/8/2018
End Date: 5/14/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $94,400
Total SCG Cost: $5,000
Total Cofunding: $89,400
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Development of Weld Landing Zone Guidance - JIP

Landing zones are the pipe surface areas where the circumferential fillet welds are deposited to attach two objects (i.e. full–encirclement Type B repair sleeve or full–encirclement hot tap fittings). Prior to welding the circumferential fillet welds, the landing zones need to be inspected to confirm sufficient wall thickness to prevent pipe wall burn through and to demonstrate the absence of defects. The objective of this JIP was to develop clearly defined acceptance criteria and landing zone requirements for circumferential fillet welds for installation of Type B repair sleeves and other full-encirclement fittings to be used during in-service welding near discontinuities. Recommendations for nondestructive tests to consistently identify and size discontinuities were also developed. The Final Report was issued, and SoCalGas subject matter experts are reviewing the study's findings to determine if existing policies should be revised.

Cofunders: JIP Members

Start Date: 6/10/2020
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $18,000
Total Project Cost: $216,000
Total SCG Cost: $18,000
Total Cofunding: $198,000
Benefits:

Effect of Upstream Piping on Ultrasonic Meter Bias (MEAS-6-5C)

The project objective is to assess the effect of end treatments on the velocity profile and the resulting ultrasonic meter performance. This aligns with the PRCI goal to increase measurement accuracy. The primary benefit from this project will be reduced measurement uncertainty of ultrasonic meters, reducing the amount of unaccounted gas. Experimental test results will be compared to CFD modeling results. The project will identify end treatments that allow for cleaning and internal inspection, while minimizing the effect on velocity profile and the overall meter performance. This information could be used to identify end treatment designs that should be avoided because they could impact meter performance. Currently, the end treatment configuration(s) that will be used to perform CFD modeling is being finalized.

Cofunders: PRCI Members

Start Date: 11/1/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $236,000
Total SCG Cost: $4,971
Total Cofunding: $231,029
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Emerging Fuels – Hydrogen (SOTA, Gap Analysis, Future Project Roadmap) (MEAS-15-02)

The PRCI project team performed an exhaustive assessment of the state of the art for hydrogen to identify R&D Gaps and propose future PRCI R&D topics (including list of contractors, cost, timeframe) and a Roadmap to safely and reliably inject hydrogen into transmission pipelines at certain blend levels. The top issues were identified to focus future research efforts in the areas of measurement and quality, compression, and inspection and maintenance. For example, the top three hydrogen gas measurement and quality challenges identified for transmission are: 1) impact on flow meter accuracy in transmission operating conditions; 2) development of gas composition analysis tools for accurate, live calorific value measurement; and 3) verification of hydrogen compatibility with ultrasonic meter sensor material and performance accuracy. SoCalGas benefits from this project because top hydrogen challenges identified and future PRCI R&D Projects to address them are of interest. The final report was issued on 11/25/2020.

Cofunders: PRCI Members

Start Date: 3/19/2020
End Date: 11/25/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $118,000
Total SCG Cost: $0
Total Cofunding: $118,000
Benefits:

Emerging Fuels – Renewable Natural Gas [RNG] (SOTA, Gap Analysis, Future Project Roadmap) (MEAS-15-03)

RNG injection into natural gas networks is a valuable solution for decarbonizing traditional energy systems, including heavy industry, heating, power generation, and transportation in the transition to a net-zero-carbon economy. This study sought to define projects that would address the technical barriers of transporting RNG in natural gas pipelines. The study was divided into four main tasks: 1) mapping of worldwide projects and references; 2) state-of-the-art analysis; 3) gap analysis; and 4) recommendations for R&D topics. The analysis focused around 10 technical subjects: 1) RNG composition; 2) injection and dilution-related impacts on gas grids; 3) safety; 4) analyzers; 5) odorization; 6) metering; 7) global injection system; 8) storage; 9) reverse flow injection system; and 10) gathering lines for biogas. The results of this study identified two RNG research priorities for 2021: 1) consolidate existing and new data on RNG trace components and create a database open to PRCI members and developers, and 2) find, develop, and evaluate a single integrated analyzer to measure main RNG components and select trace components to control gas quality of RNG injected into the pipeline.

Cofunders: PRCI Members

Start Date: 4/7/2020
End Date: 12/15/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $118,000
Total SCG Cost: $0
Total Cofunding: $118,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Engine Controller Design Solutions to Address Variable Fuel Composition of Lean-Burn Engines: Field-based Evaluation (CPS-14-03)

The PRCI project team plans to use field-based empirical data and a gas-turbine-powered simulation tool to computationally predict engine response (power, efficiency, and emissions) as fuel composition changes. Ethane is the primary constituent being studied, but the models could be used for other advanced fuels such as hydrogen. Findings from a sensitivity study performed with these simulations indicate that ignition delay is nontrivially sensitive to fuel speciation, but is much more sensitive to mixture temperature, pressure, and equivalence ratio. Further, it is shown that the fluctuations in ethane content of the fuel tend to drive the largest changes in ignition delay compared to the heavier hydrocarbons. Results of this research will allow operators to accurately capture fuel variability as part of a modified control method.

Cofunders: PRCI Members

Start Date: 2/28/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $117,056
Total SCG Cost: $30,912
Total Cofunding: $86,144
Benefits:

Enhance Risk Assessment Tools for Decision Making (9.20.a)

The project objective is to develop state-of-the-art data analytics and Bayesian network approaches for assessing and managing complex systems risk. The data integration, normalization, quality management, and analytics techniques developed will improve risk-informed decision support frameworks in infrastructure integrity assessments and risk reduction. The deliverables of this project will be methods and software tools to help operators of natural gas pipelines better estimate risks and improve risk-mitigation decisions.

Cofunders: OTD Members, PHMSA, Others

Start Date: 1/1/2020
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $24,000
Total Project Cost: $1,739,097
Total SCG Cost: $56,567
Total Cofunding: $1,682,530
Benefits:

Enhancing Strain Capacity of Pipelines Subject to Geohazards (SBD-1-6)

When pipeline segments encounter geo-hazards that may cause high longitudinal stresses or strains, an engineering-critical or risk assessment may be necessary. If pipeline strain capacity is suspected to be inadequate, operators may seek viable options, such as reinforcement of the pipeline segment to withstand the higher stress or strain, especially for girth welds. In Phase 1, the project team performed a full-scale evaluation of the effectiveness of Type B sleeves and weld cap reinforcement to enhance the strain capacity of girth welds. Phase 2 focused on investigating the application of Composite Repair Wrap to reinforce girth weld strain capacity. Physical laboratory testing was completed. The Draft Final Report has been sent out to project members for review and comment.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $354,000
Total SCG Cost: $14,320
Total Cofunding: $339,680
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Evaluate Higher Strength Consumables for Manual Root Beads in X70 Girth Welds (MATH-5-4)

Many girth weld failures in newly constructed pipeline in North America are caused by undermatching strength and/or HAZ softening. A contributing factor to undermatching strength is the use of arc welding E6010 electrodes, for the root pass, particularly in thinner materials where the root pass makes up a significant portion of the weld thickness. This project will investigate the use of higher strength electrodes, E81010 and E7010, for root pass welding to see if undermatching strength can be compensated and for some degree of HAZ softening. Avoiding girth weld failures, either during preservice hydrostatic testing, or soon after the pipeline is placed in-service, would have enormous economic value and prevent negative public perception of natural gas pipelines. The testing has been completed and the final report was submitted for technical committee review and approval for publication. SoCal Gas will evaluate the final report for implementation feasibility.

Cofunders: PRCI Members

Start Date: 1/2/2019
End Date: 1/1/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $331,025
Total SCG Cost: $8,110
Total Cofunding: $322,915
Benefits:

Evaluation of Commercially Available On-Line Analyzers for Measurement of Multiple Gas Contaminants (MEAS-9-01)

The project goal is for natural gas pipeline operators to be able to use a single online analyzer to measure multiple contaminants in the natural gas stream instead of several analyzers that are each capable of measuring one contaminant. The use of a single analyzer at a biomethane production site to monitor gas quality can save $50,000 in capital cost and $10,000/year in O&M expenses. In Phase 1, commercially available analyzers, each measuring moisture, hydrogen sulfide, and carbon dioxide, were tested with gas mixtures representing both a typical transmission pipeline and an in-house contaminant blend gas. In Phase 2, the laboratory testing results were used to select two analyzers for further testing in a field environment. The one-year field test will compare the analyzer performance with the existing single component measurement instruments to determine the accuracy of measuring all contaminant species. This project was remapped from the subprogram, Environmental & Safety.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $141,600
Total SCG Cost: $15,000
Total Cofunding: $126,600
Benefits:

Evaluation of Semi-Automatic FCAW-S Welding Process (MAT-1-4)

In this project, members of PRCI seek to develop a guideline for better process control of pipeline welding by understanding the impact of welding procedure on factors that directly control weld properties. As the first steps, the team will work to identify the primary mechanisms responsible for weld toughness variations and to assess the feasibility of controlling the behavior through changes in welding practice or essential welding variables. The outcome of this project could lead to better pipeline integrity. The project is proceeding as scheduled. The team is current analyzing the test results, after which a draft guideline will be developed.

Cofunders: PRCI Members

Start Date: 1/1/2016
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $834,968
Total SCG Cost: $10,000
Total Cofunding: $824,968
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Expansion of NYSEARCH RANGE Model (M2018-008) – Phase II-a

The project objectives are to: 1) improve the ability of the NYSEARCH RANGE model to establish interchangeability boundaries for RNG by characterizing flame lifting; 2) determine appliance performance with hydrogen blends to improve the ability of the RANGE model to establish interchangeability boundaries for Power-to-Gas RNG; and 3) specify a concentration limit for silicon-containing molecules (siloxane) in RNG that will preclude significant performance and maintenance impacts for combustion equipment. The RNG flame lifting research was completed through residential appliance burner testing and the RANGE model was updated with new correlation coefficients determined from the flame lifting studies. Phase II-a investigated a concentration limit for siloxane that will preclude significant performance and maintenance impacts for combustion equipment. Phase II-a is almost completed. The next step is to test appliances that are sensitive to siloxane impacts at a lower siloxane concentration. New or replacement appliances will be acquired, and baseline performance testing will be conducted.

Cofunders: NYSEARCH Members

Start Date: 9/28/2018
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $7,850
Total Project Cost: $543,869
Total SCG Cost: $66,080
Total Cofunding: $477,789
Benefits:

Expert Review of Past PRCI and PHMSA SCC Studies, Gap Analysis and Road Mapping (SCC-7-1)

Both the PRCI Corrosion Technical Committee and PHMSA have sponsored projects related to the external SCC of underground steel pipelines. The project objective was to produce a summary report that highlights the results and main conclusions of past projects, and to provide a critical review of the current level of understanding of SCC in underground pipelines to aid PRCI members to obtain relevant information about SCC and to assist with decision-making when addressing SCC problems. The results and conclusions from 71 reports have been summarized and categorized in the final summary report. Forty-six reports are from PRCI, 12 from PHMSA, and 13 from other consortium-funded projects. This study also performed a gap analysis to provide a roadmap for future research in external SCC in underground pipelines.

Cofunders: PRCI Members

Start Date: 4/1/2019
End Date: 4/15/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $125,977
Total SCG Cost: $10,000
Total Cofunding: $115,977
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Fault Displacement Hazard Initiative (UCLA)

The project goals are to develop a suite of robust and reliable models for forecasting the distribution and magnitude of primary and distributed displacements from surface rupture, and to develop guidelines for using the models in engineering applications. Displacements from surface fault rupture can have adverse effects on infrastructure that crosses over or is built on faults. A comprehensive database of fault displacement has been compiled. The database includes 66 earthquakes with magnitudes ranging from 5 through 8. This database is three times larger than the database currently used to estimate fault displacement. Increasing the size of the database will allow more robust statistical analysis of the data for fault displacement estimates to be performed. Results of this research can be integrated into a risk assessment model and provide a method to calculate the risk of pipeline rupture during a seismic event.

Cofunders: Other Project Sponsors

Start Date: 11/20/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,415,000
Total SCG Cost: $150,000
Total Cofunding: $2,265,000
Benefits:

Field Manual for Spacing Between Pipelines and AC Grounding Equipment (EC-6-8)

The project's objective is to develop a field manual to provide guidance on the minimum safe distances between natural gas transmission pipelines and AC grounding systems without having to perform a time-consuming and costly grounding study. The latest work on the project involved completion of the construction of the soil containment test enclosures for impulse testing of arc sustainment from AC current source through different soil types and conditions.

Cofunders: PRCI Members

Start Date: 1/31/2017
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $118,000
Total SCG Cost: $9,759
Total Cofunding: $108,241
Benefits:

Field Test NeverWet & Other Nano-Tech Coatings to Reduce Aboveground Corrosion (5.17.p)

This project investigates unique and promising coatings for challenging aboveground utility corrosion prevention applications. Corrosion is an ongoing threat to the integrity of metallic utility assets. For aboveground assets, one cannot rely on cathodic protection to back up coating protection. Therefore, specifying and applying the most appropriate and best-performing coating system is even more important. The unique and promising coatings that are available in the market have the potential to substantially reduce wet/dry aboveground corrosion in a wide variety of applications. Unfortunately, the NeverWet technology was discontinued, so it could not be included in the field trials. Field testing continued with three coatings being applied per the field test protocol. The project is in the planned "field exposure" phase, with the coatings logging time at their respective application sites. The plan was for the field test to include four seasons of exposure and then to assess performance. Due to COVID-19 restrictions, the field trial has been extended. The extra time of exposure will benefit the meaningfulness of the assessments.

Cofunders: OTD Members

Start Date: 9/6/2017
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $187,000
Total SCG Cost: $1,347
Total Cofunding: $185,653
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Flow Testing of FS500 Meters (MEAS-6-11A)

The goal of this project is to ensure SICK 4" and 6" FS500 ultrasonic meters can be installed in an existing meter run pipework and not require the AGA 9 20D upstream piping or flow conditioner. The FS500 ultrasonic flow meter has been identified as a replacement for low-pressure rotary meters. This research will expand the data set previously collected from the SICK 2-inch and 3-inch FS500 ultrasonic meters to include results for 4-inch and 6-inch meters. Additionally, this research will examine the effects of the location of the pressure and temperature measurements used for determining the standard flowrate. This technology addresses significant maintenance and reliability issues associated with all sizes of rotary meters and 4" and 6" size turbine meters. This project was remapped from the Operation Technologies subprogram.

Cofunders: PRCI Members

Start Date: 7/27/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $118,468
Total SCG Cost: $22,968
Total Cofunding: $95,500
Benefits:

Full Thickness Weld Tensile Round Robin (AP-2-1A)

PRCI and its members developed a full-thickness tensile test procedure to better address mechanical measurements in narrow groove or gap welds. This new test procedure addressed deficiencies in the AWS standard B.4.0, Annex D, a recommendation on tensile strength testing for narrow or gap welds. The testing results from the procedure demonstrated the repeatability in the tensile strength measurements for narrow groove or gap welds that led to recommendations and corrections to improve the AWS standard. The recommendations and corrections also improved the predictive capabilities of pipeline integrity management in strain-based design decisions for thick-wall pipes greater than 12mm in thickness. The procedure's reliability and accuracy in measuring tensile strength of narrow groove or gap welds would lead to more reliable and safe designs and welding process/procedure selection for thick-wall pipelines. With the project recommendations and corrections incorporated into AWS standard B.4.0, SoCalGas plans to incorporate the results into its engineering practice in the future to improve pipeline integrity.

Cofunders: PRCI Members

Start Date: 2/28/2018
End Date: 6/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $212,400
Total SCG Cost: $4,642
Total Cofunding: $207,758
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Full-Scale Surface Loading Testing of Buried Pipes Vibratory Compactor and Temporary Crossing (ENV-6-2)

This project will provide guidelines on the minimum backfill depth and temporary surface covers for buried pipelines subjected to vehicular loads and vibratory compactors. Full-scale surface loading tests were completed with four different types of vibratory compaction vehicles going over buried pressurized and non-pressurized pipes. The tests also included vehicle load testing of temporary steel plates and wood mats over buried pipelines to assess their ability to reduce pipe stress. On-pipe strain gauges were installed to measure the induced stresses. The data will be used to validate the company's current modeling program for vehicular loads at construction sites where soil coverage is shallow or the vehicular loads are higher than normal highway loads. Currently, no established criteria are available to allow pipeline operators the ability to determine the soil coverage that should separate a pipeline from a soil compaction operation to ensure pipeline safety. The data from the project could also address this gap. The field test data and results are currently being analyzed and evaluated. The project is expected to be completed by the second quarter of 2021.

Cofunders: PRCI Members

Start Date: 2/28/2018
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $147,995
Total SCG Cost: $9,899
Total Cofunding: $138,096
Benefits:

Gas Composition and Quality

This project includes three parts. First, because RNG from non-conventional sources contains trace constituents that impact pipeline integrity and combustion equipment performance, SoCalGas is evaluating if an on-line or mobile analyzer is needed to measure the trace constituents in biomethane supplies, determine acceptable concentration levels, and explore effective removal methods prior to injecting it into the natural gas pipeline or delivering it to customers. The pandemic delayed this part. Second, the team sought to determine if trained dogs can pinpoint pipeline leak locations during hydrostatic testing by detecting small concentrations of DMS injected into the pipeline. This proved unreliable and was terminated. Lastly, the HYREADY JIP Program will deliver practical guidelines to support system operators in preparing networks and connected end-users for adding hydrogen to natural gas at acceptable risk levels. HYREADY JIP has developed engineering guidelines for preparing natural gas systems with hydrogen/natural-gas mixtures for transmission and distribution systems, end-use appliances, and compressors. 2021 work includes subsurface storage, hydrogen injection facility design, and 100% hydrogen transmission systems.

Cofunders: N/A

Start Date: 1/1/2017
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $9,658
Total Project Cost: $175,000
Total SCG Cost: $175,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Gas Machinery Research Council (GMRC)

With 70+ member organizations, GMRC is a community of natural gas companies dedicated to investigating technical issues within the rapidly evolving gas machinery industry and uncovering innovative solutions that improve the reliability, efficiency, and cost-effectiveness of mechanical and fluid systems. GMRC provides members and industry an opportunity to exchange information and ideas and participate in applied research and technology programs. GMRC accepts proposals relevant to current issues facing the gas machinery industry seeking to improve the quality and efficiency of pipeline facilities and gas compressor stations. In 2020, GMRC active projects included: Analytical Lube Oil Model Development; Dry Gas Seal Reliability-Phase 3a; Development of a Robust Scrubber Level Control; Fiber Optic Sensor for Dynamic Strain and Non-Invasive Dynamic Pressure Measurements; High-Pressure Vapor Equilibrium Measurements of Gas/Water Mixtures using NMR Spectography with NIST; Reciprocating Compressor Lubrication Optimization; and Virtual Orifice Standardization. This project was remapped to Systems Design & Materials.

Cofunders: GMRC Members

Start Date: 1/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $4,000
Total Project Cost: $280,000
Total SCG Cost: $12,000
Total Cofunding: $268,000
Benefits:

Gas Quality Resource Center – Phase 1, 2, 3 (7.11.a)

The objective of the GQRC was to establish a center of excellence at GTI to provide information and expertise on issues surrounding gas quality, interchangeability, and potential implications from the introduction of new gas supply sources—such as renewable and unconventional gas—into gas transmission and distribution systems. Phase 1 created a project advisory committee to develop the idea into a useable relational database; Phase 2 developed a website; and Phase 3 automated data processing through a web application. Six of nine modules were developed and populated: Pipeline Tariffs, FERC Summary, Gas Quality Profiles, Technical Publication Library, Current Research, and Gas Quality Analysis. With technology changes, the GQRC website and its contents require updating. GTI recommended moving the GQRC fundamentals to the platform used for the Trace Constituent project and closing out this project. This project was remapped from the Operations Technologies subprogram.

Cofunders: OTD Members

Start Date: 1/2/2012
End Date: 12/28/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $460,000
Total SCG Cost: $60,000
Total Cofunding: $400,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Geohazard Management Joint Industry Practice

This collaborative project focused on identifying best practices and creating a white paper that provides guidance to identify, monitor, and mitigate the impacts of ground movement on operating pipelines. The engineering consulting firms participating in the study prepared a practical, concise document that provides recommended practices that focus on landslide management. The White Paper, Guidelines for the Management of Landslide Hazards for Pipelines, provides a summary of recommended processes and steps that pipeline operators can use to provide a consistent framework for proactively managing landslide hazards that can or may affect their pipeline systems. The management guidelines help operators to identify, characterize, mitigate, monitor actual and potential landslide hazards, and provide guidance to perform fitness-for-service assessments of pipelines affected or potentially affected by landslide movement.

Cofunders: JIP Members

Start Date: 5/26/2020
End Date: 8/17/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $336,000
Total SCG Cost: $0
Total Cofunding: $336,000
Benefits:

Guidance on the Use, Specification and Anomaly Assessment of Modern Line Pipes (MATH-5-3B)

Girth weld incidents (i.e. leaks and rupture) have occurred during hydrostatic proof tests and in-service of newly constructed pipelines in recent years. For in-service pipelines, this project provides processes and procedures to assess the risk of having similar girth weld incidents. These processes and procedures will enable the effective use of resources for mitigation when needed. They will also enable the development of recommendations to minimize the risk of girth weld incidents for near-term construction projects and pipelines to be constructed in the future. The improved line pipe specifications and welding practice should lead to strain-resistant girth welds and pipelines resistant to anomalies, such as corrosion and mechanical damage. To date, four out of five guidelines for assessing welds have been completed and approved. The remaining guideline has been drafted and submitted for review and approval.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $5,000
Total Project Cost: $743,402
Total SCG Cost: $20,292
Total Cofunding: $723,110
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

HAZ Softening Susceptibility Tests Development (MATH-5-3C)

Unexpected girth weld failures can occur in newly constructed pipelines, with time elapsed from construction to rupture ranging from a few weeks to a few years. Most failures occur in-service and some during preservice hydrostatic testing. HAZ softening is one of the contributing factors. Failure is caused by the loss of the mechanical strength (softening) of the pipe around the weld that produces the HAZ where the base metal experiences thermal cycling. HAZ softening occurs in low-carbon or carbon-equivalent steels. This project's objective is to develop a test for low-carbon steels' susceptibility in the HAZ of a weld. The test will characterize the loss of mechanical strength in HAZ of the base metals. The project will also attempt to develop welding procedures that might prevent HAZ softening. The project results will lead to safer pipeline designs through better material selection, and pipeline repairs that use welding. The project has collected pipe weld samples from project participants that are being prepared for testing. Some samples have already been tested. Once the testing is completed, the result will aid in the development of a procedure to prevent HAZ softening.

Cofunders: PRCI Members

Start Date: 7/24/2020
End Date: 7/24/2022
Status: Active
2020 Funds Expended: $5,000
Total Project Cost: $218,300
Total SCG Cost: $7,400
Total Cofunding: $210,900
Benefits:

Heavy Hydrocarbon Compound Dew Point in Natural Gas Pipelines (MEAS-15-01)

To maintain the integrity and reliability of natural gas transportation infrastructure, system operators ensure that products in transit remain in the gas phase under foreseeable operating conditions. Compliance with pipeline HCDP specifications is demonstrated through in-situ testing or predictive models based on equations of state calculations. This project conducted a literature search on the uncertainties associated with measuring heavy-end hydrocarbon compounds and calculating the onset of liquid drop-out. A mathematical method was developed for consolidating the uncertainties and producing a graphical representation that maps the statistical confidence of a HCDP prediction, given information about the measuring system and expected gas composition. The project results recommend development of a new, practical definition of allowable condensable liquid content within natural gas streams and revisions to tariff language to address the use of calculated as well as in-situ determination of HCDP. SoCalGas will use findings of this report to improve onsite determination of HCDP at all producer sites to verify compliance with tariffs.

Cofunders: PRCI Members

Start Date: 9/4/2018
End Date: 2/16/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $47,200
Total SCG Cost: $3,905
Total Cofunding: $43,295
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

High Pressure Calibration of Turbine/ USMs With Inert Gas (MEAS-6-22)

This research focused on the development of a model enabling gas turbine meter calibration with inert gas to be used in natural gas applications in a manner sufficiently representative for the gas industry. High-pressure flow calibrations of gas flowmeters with an inert gas could be more cost-effective than calibration with natural gas since safety measures attached to using natural gas as a calibration medium could be avoided. A comprehensive literature review identified several potential models that could be used for turbine meters. These models were evaluated and modified to produce a robust model based on a polynomial function of the logarithm of Reynolds number with an additional term to account for flowmeter performance at low Reynolds numbers. The theoretical response model was validated with calibration data provided by PRCI members and with experimental data from a 4-inch and an 8-inch turbine flowmeter tested in natural gas at two pressures. A function to translate the results of a gas meter calibration with an inert gas to natural gas has been developed.

Cofunders: PRCI Members

Start Date: 5/15/2018
End Date: 6/17/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $427,778
Total SCG Cost: $0
Total Cofunding: $427,778
Benefits:

Hot Tap Branch Connections, JIP

This JIP develops industry best practices for welding hot tap branch connections onto live gas mains, including a compendium of properly qualified procedures for welding stub-on-type branch connections to in-service pipelines and a guideline that allows the least-complicated procedure to be selected for a given application. The development and use of industry best practices for specifying and installing hot tap branch connections will reduce cost and increase safety and reliability. The results of this project may identify instances where in-service welding may be acceptable and where it is currently prohibited. This will allow significant economic and environmental benefits to be realized. The development of a comprehensive report discussing in-service failures or near failures of pipelines and facilities has been completed. Guidance documents and welding procedures are being developed.

Cofunders: JIP Members

Start Date: 12/16/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $ 0
Total Project Cost: $1,050,000
Total SCG Cost: $30,000
Total Cofunding: $1,020,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Hydrogen Blend into Natural Gas – Phase 2: Metallic Materials (6.14.b.2)

Hydrogen is considered as an important energy carrier in the future for sustainable, reliable, and cost-effective energy. As an energy carrier, hydrogen will help provide secure energy supply by utilizing locally available energy resources such as wind, solar, biogas, nuclear, etc. Hydrogen also contributes to a reduction of carbon dioxide emissions and air quality improvement by replacing fossil fuels with hydrogen produced from renewable energies. The objective of this project is to conduct physical testing to assess the impacts of 5% hydrogen blended fuel on metallic materials in the natural gas pipeline system. In addition, the project will develop engineering tools to allow an integrity assessment and a safety margin determination for hydrogen blended gas use. To date, a literature review and a hydrogen-blend use case to bound testing and engineering modeling requirements have been completed. Development of the testing matrix is underway.

Cofunders: OTD Members

Start Date: 4/15/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $25,760
Total Project Cost: $240,000
Total SCG Cost: $53,760
Total Cofunding: $186,240
Benefits:

Hydrogen Embrittlement and Crack Growth (Phase 1a, 1b, 2)

The objective of this study is to characterize the FCGR behavior of different grades of steel pipe in a range of hydrogen-natural gas mixtures. The FCGR will be determined for base metal, longitudinal seam welds, and girth welds at both weld center line and HAZ. Each phase will test by pipe grade: Phase 1a: X70, Phase 1b: X52 and X65, and Phase 2: vintage Grade B and X52. In 2020, Phase 1a completed the evaluation of X70 pipe. The draft final report showed that the FCGR was accelerated for the various microstructures in the environments (i.e. hydrogen blends) caused by hydrogen embrittlement mechanisms. SoCalGas will use this knowledge to understand the effects of hydrogen embrittlement on steel pipe, as well as to direct additional research. Phase 1b and Phase 2 testing is in process.

Cofunders: N/A

Start Date: 11/1/2019
End Date: 1/31/2022
Status: Active
2020 Funds Expended: $272,173
Total Project Cost: $1,017,660
Total SCG Cost: $1,017,660
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Identification and Development of an Analyzer for Siloxane Measurement (M2018-010) Ph II

Siloxanes are man-made organic compounds that contain silicon, oxygen, and methyl groups. Due to an increase in silicon-containing personal hygiene, health care, and industrial products, the presence of siloxane in biomethane derived from anaerobic digestion of waste from landfills and wastewater treatment plants has increased. Combustion of RNG containing siloxanes produces a silica deposit on downstream surfaces that can impact the safety and reliability of appliances and efficiency of industrial equipment. Phase I evaluated analyzers in the laboratory and the field. A Phase II objective is to identify a suitable portable technology that can measure low levels of siloxane concentrations (~0.1 mg Si/m^3). Once the technology is selected, the research team will create a plan to develop an instrument with a company that specializes in the technology. A subsequent objective would include work with other gas companies or RNG suppliers to test the instrument in a wide range of applications. This will develop data and information on the presence of siloxanes in RNG and could be used to develop a standard on acceptable siloxane levels. The project is seeking hosts for field evaluations.

Cofunders: NYSEARCH Members, Others

Start Date: 1/31/2021
End Date: 8/1/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $256,203
Total SCG Cost: $28,940
Total Cofunding: $227,263
Benefits:

Impact of Hoop Stress and Percentage of SMYS on Pipelines (4.20.a)

This study will determine whether specific pipe segments operating between 20-30% SMYS are safely operating as distribution lines under DIMP or should be reclassified as transmission lines and be operated under 49 CFR 192 Subpart O. Likewise, the study will indicate which, if proven safe, transmission lines operating between 20-30% SMYS can be safely transferred into the distribution classification and safely operated under DIMP. This project completed a knowledge-based study that investigated definitions for natural gas transmission and distribution pipelines in 49 CFR 192, completed a regulatory review and an in-depth literature review of historical technology and trends for steel pipes, reviewed NTSB and PHMSA Incidents data and reports for natural gas transmission pipelines, conducted a Sensitivity Study on DOE and Failure Mode Categorization, and performed a Gap Analysis between 49 CFR 192 code requirements and the framework defined in this study. Additional emphasis was placed on 20-30% SMYS segments and included leak vs. rupture considerations and effects on failure modes and related risk consequences. The draft final report has been issued for review and comment.

Cofunders: OTD Members, PHMSA

Start Date: 10/21/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $10,000
Total Project Cost: $551,902
Total SCG Cost: $10,000
Total Cofunding: $541,902
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Impact of Hydrogen/Natural Gas Blends on LDC Infrastructure Integrity (M2020-002)

The objective of this project is to determine if blending hydrogen into natural gas will change the physical properties of elastomers in a natural gas delivery system. The most common elastomers in the natural gas industry are SBR and NBR, which are used as seals in compression applications and as gaskets for flanges in joining pipes and fittings. The lack of data on the effect of hydrogen concentrations in hydrogen/natural gas blends on elastomers in a natural gas infrastructure (e.g. piping, piping components, and appurtenances) may impact the safety and reliability of the gas delivery system. Phase 1 will perform exploratory tests using a limited set of test gas mixtures. Phase 2 will perform further tests on field-extracted and virgin materials using an expanded set of test gases. The current baseline testing and creep tests have been completed. Preliminary data showed the presence of hydrogen impacts creep data over time, especially on the SBR elastomers. The results showed the exposed samples were not shrinking as much as the unexposed samples. The tests for stress relaxation in elastomers are still ongoing.

Cofunders: NYSEARCH Members

Start Date: 6/30/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $11,565
Total Project Cost: $138,891
Total SCG Cost: $11,565
Total Cofunding: $127,326
Benefits:

Impact of Trace Constituents on Odor Masking (7.21.c)

Natural gas production contains numerous chemicals that are removed at gas processing plants prior to injection into the natural gas pipeline system. After treatment, there are still trace amounts in the processed gas. Some of these chemicals may act as odor-masking agents, preventing people from smelling gas leaks. This study will identify TCs that act as odor masking agents. The results of the study will be used by industry to determine how to mitigate the masking effect of masking agents. The effort will lead to safer gas operations for utility workers and their customers.

Cofunders: OTD Members

Start Date: 3/1/2021
End Date: 3/1/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $17,578
Total Cofunding: $132,422
Benefits:

Implications of Odorant Dispersion in a Natural Gas Pipeline (7.16.d)

The goal of this project was to determine how far downstream of an odorant injection point should the transition to PE pipe or polymer materials be located, and the proper location for a sampling point for odorant concentration and monitoring. Knowledge of where polymeric materials may be properly located in a pipeline system and not be subject to liquid odorant permeation will improve the integrity and safety of the PE pipeline infrastructure. Results of this research showed a minimum of 100 pipe diameters from an injection type odorization station is recommended before any transition to PE pipe or any gas sample is extracted for odorant monitoring. This information will allow operators to make the best decisions regarding odorization dispersion issues for their specific system. This project was remapped from the Environmental & Safety subprogram.

Cofunders: OTD Members

Start Date: 8/15/2016
End Date: 3/9/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $231,709
Total SCG Cost: $51,709
Total Cofunding: $180,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Kiefner Interactive Threats Project (T-768)

Federal regulation 42 CFR 192, Subpart O and supporting standards such as ASME B31.8S provide guidance on individual threats and their assessment. Although this standard specifically mentions that threat interactions should be addressed, there is limited industry knowledge on the interactions of various threats and how they influence the overall risk of a pipe segment. This project is developing risk models that perform a systematic review of threats that may impact pipeline integrity by identifying threats that could potentially interact and under which circumstances. It quantifies the increased likelihood or probability of failure attributable to the interaction of threats and provides a software tool to calculate this increased likelihood. To ensure that the NYSEARCH/Kiefner Interacting Threats Model stays current, annual incident data from PHMSA's and Kiefner's forensic failure databases are incorporated into annual software version upgrades for five years. In January 2020, data for 24 new interacting threat incidents that occurred in 2018 (PHMSA database) were added to the report and risk assessment tool. The last annual update is expected in Q1 2021 with a final report.

Cofunders: NYSEARCH Members

Start Date: 11/30/2015
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $264,837
Total SCG Cost: $20,740
Total Cofunding: $244,097
Benefits:

MAOP and Materials Verification - Phase I (4.17.d)

The ability to use internal and/or external inspection tools to perform an integrity assessment as an acceptable regulatory alternative to hydrotesting would assure the operator of the safety of the pipeline and provide significant cost savings in complying with new regulations. It would also provide operators an integrity assessment solution for those critical pipelines that cannot be taken out of service. The project objective is to provide a software solution to assist operators to comply with pending MAOP and Materials Verification requirements that are part of the Notice of Proposed Rulemaking Integrity Verification Process. This includes enabling the use of Engineering Critical Assessments in lieu of a hydrotest, derating, or pipe replacement. It will also support pipe surface-based nondestructive measurements in lieu of cutouts and minimize the number of destructive tests. The project is currently working on ECDA enhancements.

Cofunders: OTD Members

Start Date: 9/8/2017
End Date: 8/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $96,000
Total SCG Cost: $4,364
Total Cofunding: $91,636
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Material - Supplier Quality Assurance Program (5.17.g)

Natural gas utilities are required by federal and state regulatory agencies to implement integrity programs that focus on risk assessment of their systems, including purchased material. The regulators hold gas utilities responsible for the quality of the materials installed. However, the manufacturers producing materials for the industry are not under the same level of scrutiny or regulatory oversight. The objective of this project is to assist gas utilities in creating best practice guidelines to develop and manage material supplier quality assurance programs. Additionally, this project aims to identify and select comprehensive regulatory and technical requirements specific to products utilized in natural gas transmission and distribution systems. Under this program, a material supplier quality manual, several generic material specifications, and several quality procedures were created. The project has almost completed development of all material specifications and quality procedures. The remaining few are expected to be completed first quarter 2021 followed by a sponsor review meeting to wrap up the project.

Cofunders: OTD Members

Start Date: 12/1/2018
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $431,000
Total SCG Cost: $5,000
Total Cofunding: $426,000
Benefits:

NDE Material Strength Verification for an Index of Long Seam Fracture Toughness of ERW Pipes JIP

The Gas Pipeline Advisory Committee and PHMSA set expectations that more material strength verification will be required per the first part of new gas transmission rules. This JIP investigates pipeline material strength verification and expands validation of the HSD tester for ERW pipes. The JIP will add strategic value to the process of evaluating the steel grade and quality of existing assets by obtaining tighter confidence intervals from nondestructive testing of the HSD tester. Last year, nondestructive data and conventional destructive lab data for 67 pipe joints were reported. In 2020, an additional 13 pipe joints completed nondestructive and destructive testing. For the HSD testing, the project also completed five testing service projects for SoCalGas totaling 17 samples. The project is now using that data to update the previously developed models and will close-out the program with a supplemental report summarizing the final results.

Cofunders: JIP Members

Start Date: 1/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $ 0
Total Project Cost: $400,000
Total SCG Cost: $50,000
Total Cofunding: $350,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Odor Detection Threshold Study - Phase II , Tasks 1 & 2 (M2016-002)

This project is a continuation of the natural gas odor detection threshold study using the odorant thresholds (human detection levels) determined in Phase I and focusing on understanding how the introduction of conditional factors such as odor adaptation and odor-masking agents affect detection and recognition thresholds (human senses). The two phenomena will be studied in parallel; however, the results will be provided independent of one another to better understand the effect of each variable. This study has the potential to inform decision making regarding odorization of natural gas. The contractor has completed the odor adaptation task of the project. The odor-masking effects on odorants is proceeding as scheduled.

Cofunders: NYSEARCH Members

Start Date: 11/16/2019
End Date: 10/1/2021
Status: Active
2020 Funds Expended: $13,100
Total Project Cost: $468,950
Total SCG Cost: $48,100
Total Cofunding: $420,850
Benefits:

On-Line Biomethane Gas Quality Monitoring - Phase 2, Trace Sensors (7.16.e.2)

This project's objective is to validate the ability of industry technologies ranked as most promising in Phase 1 to monitor unconventional trace contaminants (e.g. siloxanes, VOCs, sulfur, and hydrocarbons) found in biomethane. The focus is on constituents that are not routinely monitored by on-line instruments, and that are critical to gas quality. The project will determine if an on-line or mobile analyzer is needed on biomethane supplies delivered, from local gas suppliers directly to customers, to ensure that gas supply meets specification. The validation methodology includes preparing artificial biomethane samples for four analyzer manufacturers to analyze. The results will be compared with the sample data to determine analyzer performance. Three of the four test samples have been shipped. The last set is due to ship the beginning of 2021.

Cofunders: OTD Members

Start Date: 3/1/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $125,000
Total SCG Cost: $2,890
Total Cofunding: $122,110
Benefits:

Optimize the Detection and Mitigation of Mechanical Damage (SRP-MD-01)

Detecting and mitigating mechanical damage to pipeline infrastructure is a major concern to the natural gas industry. PRCI established this SRP to coordinate the efforts across all of the technical committees (Compressor Pump Station, Design Materials Construction, Surveillance Operations Monitoring, Measurement and Underground Storage). The SRP goal is to provide a roadmap of research projects to close the gaps on MD research and produce a comprehensive set of guidelines and tools for managing the threat of MD. This SRP funded one project in 2021: Analysis of Pipeline Operator and Prior R&D data (MD-2-5).

Cofunders: PRCI Members

Start Date: 1/1/2021
End Date: 12/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,042,507
Total SCG Cost: $3,685
Total Cofunding: $2,038,822
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Pathway to Achieving Efficient and Effective Crack Management (SRP-CM-01)

This research intends to advance critical areas associated with the execution of crack management programs that eliminate crack-related failures. PRCI established this SRP to coordinate efforts across all of the technical committees (Compressor Pump Station, Design Materials Construction, Surveillance Operations Monitoring, Measurement and Underground Storage). The SRP goal is to provide a roadmap of research projects to further understand and efficiently and effectively manage cracks in pipelines. Research will be focused on four core areas: Susceptibility, Inspection, Management, and Assessment and Remediation. The SRP funded one project in 2021: Understanding Why Cracks Fail (MAT-8-3).

Cofunders: PRCI Members

Start Date: 1/1/2021
End Date: 12/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $5,193,400
Total SCG Cost: $21,252
Total Cofunding: $5,172,148
Benefits:

PE Saddle Heat Fusion Rounding Clamp Evaluation

This project evaluated the effectiveness of pipe rounding devices to reduce PE pipe ovality to allow for quality saddle fusions of PE fittings. An oval pipe can make performing saddle fusions difficult due to improper fit between the pipe surface and the base of the saddle fitting. Therefore, a set of rounding inserts designed to temporarily re-round the pipe while performing a saddle fusion could ensure a quality fusion. The evaluation using a set of prototypes confirmed the effectiveness of the rounding inserts. The final report was completed and distributed to the company's subject matter experts. SoCalGas used the results to work with a machine shop to produce the rounding inserts for deployment to its gas operations group.

Cofunders: N/A

Start Date: 9/14/2018
End Date: 8/15/2020
Status: Completed
2020 Funds Expended: $6,850
Total Project Cost: $39,666
Total SCG Cost: $39,666
Total Cofunding: $0
Benefits:

Pipeline Integrity Tool Cloud Based Assessment Software Consortium Project (MAT-8A / JCAS-01)

The project objective is to develop an improved model for pipeline seam weld anomalies and to deliver an updated model to project participants as a cloud-based software. The goal of this JIP is to improve the existing PRCI, MAT-8A, fracture mechanics model and its input parameters. The final product will be a cloud-based software that uses probabilistic fracture mechanics in conjunction with the updated MAT-8 model. The new software will allow operators to optimize resources through the evaluation of different mitigation scenarios. The project is near completion. The MAT-8 model has been updated and the team is moving into beta testing of the cloud-based software.

Cofunders: PRCI Members

Start Date: 9/1/2019
End Date: 9/1/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $519,695
Total SCG Cost: $47,245
Total Cofunding: $472,450
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Post Fire Debris Flow Studies

This project explored analysis methodologies and modeling options to help determine the path forward for a risk framework for post-fire debris flow risk assessments. Results from the analysis determined that additional study was needed to further develop the approach in determining likely debris flow paths. An additional pilot study using RAMMS software was chosen to assess the likelihood and extent of debris flows from heavy rain across the Montecito region. RAMMS debris flow model parameters will be calibrated using newly released USGS data for the debris flows that occurred in Montecito in January 2018. The USGS data included estimated volume of debris flows from specific basins, peak velocities, and flow properties, and contained shapefiles with the extent of the debris flows. The calibrated model parameters will be used to evaluate the entire Montecito region. The final report is being prepared.

Cofunders: N/A

Start Date: 2/28/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $17,150
Total Project Cost: $62,420
Total SCG Cost: $62,420
Total Cofunding: $0
Benefits:

Practical Effects Rough Walled Pipe Gas Metering Applications (MEAS-6-5D)

This project investigated the effects of upstream meter tube inner wall roughness as applied to the performance of multipath ultrasonic flow meters through a set of experiments involving three different brands of ultrasonic flow meters. In addition, tests were conducted on 16-inch meters with piping, having a wide variation in surface roughness values with and without a flow conditioner. These results, when combined with the 8-inch diameter meters, can be used to support changes in the practices currently recommended by industry standards. The results of these tests and those for the 8-inch diameter ultrasonic flow meters suggest that the surface roughness of the piping immediately upstream from the flow meter or between the flow conditioner and the flow meter has little influence on the accuracy of the meter. The final report has been issued for sponsor review.

Cofunders: PRCI Members

Start Date: 11/1/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $236,000
Total SCG Cost: $13,383
Total Cofunding: $222,617
Benefits:

Product Performance and Validation Program (5.20.m)

This project will test common products for the natural gas utility industry to validate that they meet industry performance standards. Utility members will have the option to select a different product from a few suppliers for testing every year. The participating utility members benefit from cost savings through the project's collaborative financial approach instead of bearing the entire cost of testing themselves. A test plan and a matrix of the product material types, configuration, size and manufacturers to be tested have been developed. The next step is to procure the products and begin testing.

Cofunders: OTD Members

Start Date: 9/1/2020
End Date: 2/28/2022
Status: Active
2020 Funds Expended: $5,000
Total Project Cost: $180,000
Total SCG Cost: $8,491
Total Cofunding: $171,509
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Quantification of ILI Sizing Performance for Severe Corrosion Anomalies (EC-4-6A)

The goal of this project was to quantify the sizing error of ILI tools as a function of corrosion feature morphology, orientation, and other geometric criteria (e.g., depth, length, width). The project developed a methodology for classifying the complex corrosion and collected 14 high-resolution laser scans with corrosion anomalies for analysis. Criteria to identify severe corrosion anomalies were developed using cluster length, average depth and maximum depth. The factors considered in the severity criteria were based on the definition of severity and the model used for burst pressure capacity prediction. Sizing errors were quantified as a function of feature depth and length, and correction models were developed for these parameters. A secure database was developed to store the anonymized high-resolution laser scan data. The results are being evaluated for potential implementation.

Cofunders: PRCI Members

Start Date: 1/15/2019
End Date: 4/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $177,000
Total SCG Cost: $9,709
Total Cofunding: $167,291
Benefits:

Review and Evaluation of the Utonomy Smart Regulator, Phase 2 (5.19.k.2)

The objective of this project is to demonstrate the operation and benefits of the USR through laboratory testing and utility field trials. The use of the USR can provide operators with remote visibility of the operations of their regulator stations to optimize system load balances and identify communication failures remotely. The regulator has the potential to significantly reduce gas leakage and unaccounted for gas loss in medium- and low-pressure gas distribution systems while increasing safety. The work effort will be coordinated with Utonomy on the project plan. The project will also identify the needs and interests of the project sponsors regarding flow testing and field evaluations.

Cofunders: OTD Members

Start Date: 1/31/2021
End Date: 1/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $291,800
Total SCG Cost: $76,644
Total Cofunding: $215,156
Benefits:

Revision of the PRCI Hot-Tap Model to Model Two Different Base Materials (MATR-3-1B)

The objective of this project is to complete the development of the PRCI HotTap Model V5, a thermal analysis model for in-service welding. This project will update software version 4.2.1 to expand the model and software to cover welding of two different materials, as well as to meet current technology standards. Modeling two different materials could allow a clear understanding of the cooling aspect of the two different materials. During the development process, sponsor feedback will be entertained. The potential exists for additional functionality to be added. The V5 model will be available to PRCI members for their use upon completion of the project.

Cofunders: PRCI Members

Start Date: 8/17/2020
End Date: 8/17/2022
Status: Active
2020 Funds Expended: $10,000
Total Project Cost: $69,620
Total SCG Cost: $19,946
Total Cofunding: $49,674
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Risk Profile for Aldyl-A Piping System - Phase 3-Squeeze Off Reinforcement Clamps (2.13.d.3)

This project developed guidelines and easy-to-use instructional procedures for installation of full encirclement reinforcement band clamps over squeezed-off areas of early vintage PE pipes. The clamp's compression strains were analyzed, and finite element stress/strain analysis was conducted to ensure that installation procedures mitigate the stress concentrations caused by squeeze-off operations that could result in initiation of slow crack growth on PE pipe. The final report provided recommended procedures for installation of reinforcement clamps with adequate compression levels that eliminate the risk of crack initiation and growth. The results of the project led SoCalGas to revise its installation procedures for reinforcement clamps.

Cofunders: OTD Members

Start Date: 6/15/2015
End Date: 4/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $277,465
Total SCG Cost: $202,965
Total Cofunding: $74,500
Benefits:

Seismic Risk Assessment and Management of Natural Gas Storage and Pipeline Structure (GFO-18-502) (Group 1)

The CEC awarded two projects under GFO-18-502, Group 1. The first was awarded to Slate Geotech and UC Berkeley for the production of an open-source analysis tool that is easily usable by regulators and utilities. The tool will implement updated methodologies for assessment of seismic risk to underground and aboveground natural gas infrastructure. The new tool, which builds upon the widely used SERA software, will be able to perform a variety of analyses at a wide range of complexity levels with optimal user functionality. The tool will have the ability to identify areas of highest risk overlaid with population information to help regulators and utilities identify areas of highest risk to prioritize seismic retrofit projects. SoCalGas provided data and technical expertise for this project. The second was awarded to UCLA, which is looking at fragility curves for pipelines and creating liquefaction and fault rupture data based on probability-based methodology. SoCalGas is participating on the TAP for this project.

Cofunders: CEC, LBNL, UCLA

Start Date: 6/1/2019
End Date: 3/30/2022
Status: Active
2020 Funds Expended: $3,657
Total Project Cost: $5,202,752
Total SCG Cost: $8,000
Total Cofunding: $5,194,752
Benefits:

Storage Well Casing Inspection Tool Sizing Accuracy

This research will perform a statistical analysis on available data from both SoCalGas and industry to establish sizing accuracy for UT and MFL downhole inspection tools used to inspect underground storage well casing. The drivers are integrity and reliability. Several existing tools do not include performance specifications for measurement accuracy of defects in length, width, and depth dimensions. Proper evaluation of remaining strength and life of storage well casing requires a thorough understanding of tool measurement accuracy. Successful completion of this analysis will give SoCalGas a better view of the accuracy of these inspection tools. The project results will be used to apply tool tolerances to inspection measurements of storage well casing by downhole inspection tools using UT and MFL sensors.

Cofunders: N/A

Start Date: 1/31/2021
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $35,000
Total SCG Cost: $35,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Study on the Impact of Trace Constituents in RNG on Natural Gas Grids and Consumer Appliances (M2020-008)

The objective of this project is to study the impact of TCs in RNG and traditional pipeline gas to address any potential safety or maintenance risks on local distribution company infrastructure and customer gas appliances. Phase 1 involves a literature search and study on all TCs in RNG. Gaps in the literature will be identified, and then addressed in preliminary laboratory tests to identify set limits for six (6) TCs of concern. These limits will assist SoCalGas in determining whether RNG specifications should be modified. The results will be distributed as a white paper. If successful in determining safe TC limits, SoCalGas plans to use the results to request changes in the Standard Renewable Gas Interconnection's sections that govern business specifications and RNG tariff.

Cofunders: NYSEARCH Members

Start Date: 1/15/2021
End Date: 11/1/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $606,810
Total SCG Cost: $71,390
Total Cofunding: $535,420
Benefits:

Sulfur Condensation in Pressure Reduction Equipment (MEAS-5-23)

This project will develop an understanding of which pressure regulator styles are less prone to elemental sulfur, or S8, deposition, assist regulator/control valve manufacturers with design considerations for future models or for current model improvements, and provide operators a lower-cost solution for S8 deposition mitigation when compared to gas heaters. The project team collected S8 samples from member companies of the PRCI in locations known for heavy sulfur deposits that have impacted regulator operation. The samples were analyzed to identify their entire chemical composition, which led to another research project to summarize the analysis of numerous sulfur samples collected from various sources across the country. Two different pressure regulators were evaluated in a side-by-side comparison over an extended period of operation. The accumulation of S8 deposits and the corresponding impact on equipment operation were recorded. One pressure regulator demonstrated superior performance to the formation and deposition of S8. SoCalGas benefited from this research because it confirmed the regulator style approved for use in areas where sulfur deposits are an issue is the best choice.

Cofunders: PRCI Members

Start Date: 1/31/2016
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $167,560
Total SCG Cost: $19,969
Total Cofunding: $147,591
Benefits:

Systematize 20 Years of Mechanical Damage Research (PHMSA) (MD-5-1)

The project provides a summary of work supporting the current state of knowledge related to mechanical damage. The focus is on formation and behavior, detection and characterization, assessment and management, remediation and repair, and recommended practices and standards. Results of this body of work will provide a consolidated review of previous research over the past 20 years characterizing the achievements made as well as opportunities for improvement. In 2020, the literature collection and review task was completed. This project was remapped from the System Inspection & Monitoring subprogram.

Cofunders: PRCI Members, PHMSA

Start Date: 9/30/2019
End Date: 3/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $493,982
Total SCG Cost: $1,753
Total Cofunding: $492,229
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Trace Constituent Database (7.18.h)

The goal is to create an online searchable GQDB with a compilation of major, minor, and TC concentrations along with sampling and measurement techniques for natural and renewable gas. There is currently no GQDB with information on methods, measurement related issues, and actual concentrations for the natural gas industry for TCs. This project will fulfill the prior GQRC project goal to aggregate gas quality information. The future home for the GQDB is being investigated. During the project kickoff meeting, it was suggested to use the GQRC schema for this GQDB, but that database framework is outdated and not optimal. In 2020, the database was completed with access via multiple Power BI reports containing interactive data visualizations and raw data tables. The application also has reports detailing sampling techniques and method information. A webinar was held with sponsors to demonstrate the functionality of the database. Feedback was solicited which will shape the finalized version of the report application. This project was remapped from subprogram Environmental & Safety.

Cofunders: OTD Members

Start Date: 9/3/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $162,000
Total SCG Cost: $8,684
Total Cofunding: $156,316
Benefits:

Tracking and Traceability for Transmission, Pipe Materials, Phase 4 (Additional Demos) (5.14.d.4)

The goal is to provide a traceability process that can be used by any pipeline operator, pipe fabrication mill, pipe coating mill, and distributor to transfer and receive asset traceability information. For this phase, a field study on steel material traceability was conducted to develop a standard data model and protocols for transferring MTR and CoC records electronically from pipe manufacturers to pipeline operators. A Working Group was formed to create an RP that will be published by the API. Operators will be able to reference this RP when purchasing pipes from pipe mills to deliver material traceability data in a standardized, electronic format. The results of a field test were submitted to the Working Group for incorporation into the RP for steel pipe. API is currently reviewing the submittal prior to publishing the RP.

Cofunders: OTD Members

Start Date: 2/8/2018
End Date: 6/1/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $265,000
Total SCG Cost: $31,346
Total Cofunding: $233,654
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Tracking and Traceability Marking Standard for Transmission Components - Phases 1 & 2 (8.17.b, 8.17.b.2)

Phase I objective is to enable the capture of key information required for documenting and geospatially modeling new or repaired gas transmission systems to support the latest PHMSA regulatory requirements. The objective of Phase II is to use the Phase I marking standard to capture key information required for physically documenting and geospatially modeling new or repaired gas transmission systems to comply with the latest PHMSA requirements. Under Phase I, GTI completed the pilot with a natural gas utility barcoding all components at either of the manufacturing facilities, distributors, or from stock components drawn from the utility's storeroom. The knowledge gained from the pilot was helpful in developing the next phases of the project. Phase II, a pilot program, was established for the demonstration of marking guidelines and its integration with GS1 synchronization network. GTI established dedicated databases that manage the mobile systems that are better prepared for future pilot project, so any product data loaded into Global Data Synchronization Network will load into the iOS application.

Cofunders: OTD Members

Start Date: 1/1/2017
End Date: 11/15/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $645,000
Total SCG Cost: $58,707
Total Cofunding: $586,293
Benefits:

Universal Analytical Technique for Siloxane - Phase 2 (7.16.g.2)

The project objective is to develop a universal industry-wide sampling and analysis procedure for measuring siloxanes in biomethane. It is being developed in conjunction with ASTM Committee on Gaseous Fuels. ASTM Standard D8230 for the Measurement of Volatile Silicon-Containing Compounds in a Gaseous Fuel Sample Using Gas Chromatography with Spectroscopic Detection was developed and published in Phase 1. ASTM requires that an ILS be performed within five years of the procedure publication date. Phase 2 will ensure the ILS is completed and will perform a field test of an online siloxane analyzer. The laboratories that will participate in the ILS are in the process of being identified. In parallel, the site location for the field evaluation was selected.

Cofunders: OTD Members

Start Date: 5/1/2019
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $19,608
Total Project Cost: $253,000
Total SCG Cost: $49,608
Total Cofunding: $203,392
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

USC BioGas Study (Phase I & II)

The goal of this project is to investigate the effect of ammonia, at various concentrations from exposure to typical pipeline materials to RNG—which is derived from biogas and processed to meet pipeline natural gas quality specifications (> 92% methane)—or from its combustion for power and energy production. Phase I of this project focused on pipeline brass-alloy containing materials and devices and the impact of their exposure to ammonia as a potential constituent of RNG. The experimental results point to the need for thorough clean-up of the RNG prior to its injection into the natural gas network. The Phase II study will evaluate the impact that ammonia presence in RNG may have on appliance and/or equipment performance, as well as investigate the impact on emissions (e.g. CO, NOx) from combusting ammonia/RNG mixtures. The completion of Phase II was delayed due to COVID-19, but the study has been completed and currently the final report is out for peer review.

Cofunders: N/A

Start Date: 8/1/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $209,765
Total SCG Cost: $209,765
Total Cofunding: $0
Benefits:

Wellhead Seals Best Practices (US-3-01)

Wellhead seals are a key component of underground gas reservoir and salt-cavern storage wells that function to seal the well from the external environment and separate stored fluids contained within the well. Loss of integrity of these seals or seal failures are a common occurrence in the storage industry. Practical guidelines on how to choose the proper sealing components and prevent seals from failing are generally lacking. In this study, data related to wellhead sealing were compiled through a literature review, discussions with wellhead experts, and a survey distributed to PRCI members and others involved in the industry. Through the evaluation of this data, meaningful parameters involved in successful seal selection and failed seals were identified for recommended practices on seal selection and wellhead design. A draft Final Report has been issued for review by project sponsors.

Cofunders: PRCI Members

Start Date: 7/30/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $4,609
Total Project Cost: $59,000
Total SCG Cost: $4,609
Total Cofunding: $54,391
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: SYSTEM INSPECTION & MONITORING

3vG Satellite InSAR Monitoring, Pilot Project

Project consultant 3vG used the Japanese ALOS to monitor a SoCalGas transmission service area. ALOS has the capability to penetrate vegetation to measure displacement of the underlying ground surface and produce images covering a 31 x 43-mile area with 3-meter resolution. Significant ground displacement could potentially cause damage to pipelines. SoCalGas compared the performance of this new system—its ability to monitor vegetated areas to identify and monitor ground movement near operating pipelines, and its internal data processing software—with existing technology. The results showed four areas with significant displacement that were identified within 2,000 ft of a Coastal Mountain pipeline. This project was remapped from subprogram, Operations Technologies.

Cofunders: N/A

Start Date: 12/1/2019
End Date: 8/30/2020
Status: Completed
2020 Funds Expended: $49,800
Total Project Cost: $49,800
Total SCG Cost: $49,800
Total Cofunding: $0
Benefits:

AC Earth Faults (9.16.d)

This project was initiated to develop methods to quantify the extent to which buried gas pipelines are exposed to ground or earth faults from nearby high-voltage AC power systems and to examine the risks caused by this exposure. A ground fault occurs when the pathway of straying electrical current is directly to the earth (to the ground). These fault events have the potential to damage pipeline coatings with the risk that the damage can go unnoticed. A model that can show where earth faults are likely to occur is needed to improve knowledge of fault "hot zones," which would allow utilities to plan inspection and mitigation efforts, as well as conduct proper risk assessments. A commercial software package has been acquired to perform risk modeling. A project sponsor provided pipeline and electric system data for a case study to test the risk model. Once testing is completed, a demonstration of the risk model will be scheduled for project sponsors.

Cofunders: OTD Members

Start Date: 10/1/2016
End Date: 2/28/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $289,200
Total SCG Cost: $70,000
Total Cofunding: $219,200
Benefits:

Advance Computed Tomography (CT) for Pipeline Inspection (PHMSA) (NDE-2-11)

The project team is working to deliver a validated data set and process to evaluate the use of CT as a nondestructive technology for measuring crack and seam weld anomalies in steel pipe. Validating the CT technology will enable the pipeline industry to establish a set of reference standards that can be used for a wide range of purposes, including technology development and qualification, personnel training, and competency testing. These reference standards will not require destructive testing to characterize crack profiles and can be used on a repeated basis. This is a significant step for the pipeline industry that will advance training, technology development, and integrity management programs. An essential element in this program is acquiring pipeline materials. Modern pipeline materials can be used, but the preference is to use vintage pipe, especially pipes having low-frequency ERW seam welds. The project is working to acquire these materials in preparation for testing.

Cofunders: PRCI Members, PHMSA

Start Date: 9/30/2019
End Date: 9/29/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $500,000
Total SCG Cost: $10,000
Total Cofunding: $490,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Airborne Automated Threat Detection System-Monitoring and Surveillance of Imminent Threats Through Remote Sensing (ROW-3-1&A)

The goals of the project are to develop, demonstrate, and validate the use of automated pipeline patrol and surveillance technologies on an aircraft platform to enhance detection of third-party activities, ground movement, and interferences that could potentially affect pipeline infrastructure. Project results will provide pipeline operators with performance data and information on the capabilities and limitations of airborne sensing systems for automated pipeline patrol and surveillance. Multiple PRCI members have offered to make their ROW corridors available for this program. Flights scheduled for 2020 were completed and additional flights are planned in March and April 2021. A preliminary assessment of the automated airborne threat detection system, which would contribute to an operator's Leak Detection Program, was developed and feedback from sponsors is being incorporated.

Cofunders: PRCI Members

Start Date: 11/30/2018
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $377,683
Total SCG Cost: $10,982
Total Cofunding: $366,701
Benefits:

Alternate Crack Sensor (M2016-004 Phase 1, 2, 3)

This project developed and commercialized a sensor probe system for detection of cracks in longitudinal seam welds in 20"-26" diameter natural gas pipelines. Phase 1 developed a concept to integrate the crack sensor probe with the Explorer robotic inspection platform. The overall concept involved the use of two probes, one for finding seam welds and one for scanning for cracks. In November 2018, a prototype was built and field-tested under Phase 2. The sensor was able to identify cracks in all seam welds except for ERWs. In Phase 3, enhancement of the mechanical designs, improvement of ERW seam weld detection, and integration of the graphical user interface were completed. Improvement of Data Analysis Tools and validation of the system with a field trial are under way. The remaining project milestones are to continue to investigate false positives, scan more prominent seam welds, and improve data analysis and validation.

Cofunders: NYSEARCH Members

Start Date: 7/1/2016
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $2,865
Total Project Cost: $1,632,690
Total SCG Cost: $203,894
Total Cofunding: $1,428,796
Benefits:

Analysis of ILI Technology Performance Specification for Corrosion Features (NDE-4-5)

The objectives of this project included providing materials for ILI pull testing for corrosion detection performance and comparing the performance of ILI tools on pipe samples with manufactured/machined versus real-world corrosion morphologies. This project improved the understanding of ILI tool performance on corrosion anomalies and of the impact of using real-world samples vs. machined samples for tool evaluation. The ILI pull test pipe strings are located at PRCI's Technology Development Center and are currently being used on a collaborative PHMSA and PRCI research project, NDE-4-19 - Improve ILI Sizing Accuracy.

Cofunders: PRCI Members, Pipeline Inspection Co.'s

Start Date: 1/1/2016
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $435,000
Total SCG Cost: $0
Total Cofunding: $435,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Casing Corrosion Logging Tool (US-3J)

Many storage field operators have a preferred technology, such as ultrasonic or magnetic flux leakage, to inspect and manage the integrity of down-hole well casings. However, there is no clear understanding of the relative benefits and/or advantages of the technologies. The objective of this project is to define the differences and advantages associated with each inspection technology currently available for storage field applications. This study will use characterized pipe from a previously funded PRCI research project, US-3H - Wellhead Casing Defect Characterization. The deliverable is an analysis report with performance data for the technologies. The findings from this project are expected to help operators select the best (most reliable) technology for their casing inspection program.

Cofunders: PRCI Members, PHMSA

Start Date: 4/1/2019
End Date: 7/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $324,035
Total SCG Cost: $50,000
Total Cofunding: $274,035
Benefits:

Cathodic Disbondment Detector – Phase 2 (4.12.c)

The utility industry needs tools that can assess underground metallic pipes from aboveground. Excavation is expensive and has potential risks. Any technique that provides insight prior to excavation will help to optimize utility resources. A commercial pipeline inspection tool was acquired and evaluated for Phase 1 of this project. This technology assessed coated steel pipe with the goal of identifying areas with disbonded coating. Additional field tests conducted during Phase 2 assessed features in coated steel pipe from aboveground. After the features were identified, the technology was validated and confirmed with excavations. SoCalGas identified eight candidate sites for the field evaluation of which seven were surveyed and five were excavated for validation. The post-excavation analysis showed one excavated area where the tool and utility surveys were in good agreement. The results from several other evacavated areas identified an issue with test location selection that will inform future test point locations. Ongoing surveys and field measurements are planned in the future.

Cofunders: OTD Members

Start Date: 3/24/2017
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $261,000
Total SCG Cost: $40,031
Total Cofunding: $220,969
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Computed Tomography (CT) Fundamentals with Calibration and Reference Standards for Pipeline Anomaly Detection (NDE-2-12)

The main project objective is to establish the relationship between new NDE test measurements and established standardized tests for fracture toughness. CT is positioned to greatly enhance the pipeline industry's ability to accurately detect and size cracks and crack-like features. By employing CT, the industry will be able to size cracks and crack-like features without having to destroy them for confirmation purposes, thus allowing ILI operators access to a set of truth data from which they can improve their tool performance. This research will validate a new technology that determines material fracture toughness through NDE in-ditch testing. The data could be combined with the "binning" of pipe joints that is currently performed using ILI tools. This combination reduces the need to perform costly pipeline cutouts and associated shutdown of the pipelines to prepare machined samples for laboratory Charpy-V notch tests.

Cofunders: PRCI Members

Start Date: 6/16/2020
End Date: 6/16/2021
Status: Active
2020 Funds Expended: $4,690
Total Project Cost: $311,929
Total SCG Cost: $8,687
Total Cofunding: $303,242
Benefits:

Demonstrate ILI Tool for (Small Diameter less than 6 inches) Gas Storage Piping

The project demonstrated the ability of the Quest Integrity InVista in-line inspection tool which uses UT sensors to accurately measure pipe wall loss and other anomalies and can negotiate through tight pipeline bends. This is especially relevant in small-diameter steel pipelines associated with storage field natural gas wells, which are difficult to inspect using conventional in-line magnetic flux leakage integrity inspection technologies. Water is used as the couplant between the UT sensors and inside pipe wall to transmit and receive the UT signal. The InVista tool was successfully deployed in segments of 2", 3", 4" and 6" pipeline at the Goleta Storage Field. The inspection results were field validated, and the tool was found to meet both the technical and functional needs (i.e., does it find the defects that we want to find). The demonstration was successful, and the tool was found to be useful and appropriate for deployment in the SoCalGas system.

Cofunders: N/A

Start Date: 1/1/2017
End Date: 10/31/2020
Status: Completed
2020 Funds Expended: $1,500
Total Project Cost: $603,000
Total SCG Cost: $603,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Determine the Impact of Human Factors in the Performance of In-Service NDE (NDE-2-7)

This is a multi-phase project. Phase 1 evaluated the impacts of training program quality on human impact on NDE performance. Phases 2 and 3 further investigated the effects of human factors on NDE performance for conducting Magnetic Particle Inspections and Ultrasonic Thickness Testing on pipeline components. This research assessed the potential impact of human factors (i.e., transfer of knowledge, teaching, and learning) on the performance of in-service NDE of pipeline integrity. Accurate damage assessments cannot occur when the accuracy or variability of the NDE is not well understood, especially when the NDE performance is impacted by a human operator. The last phase of the project, Phase 4, will deliver an assessment of the human variabilities in performing NDE, and standard procedures to assess NDE operator performance. The next steps are to test operators and determine variabilities. PRCI is in the process of reviewing a timeline for the finalization of the work for 2021.

Cofunders: PRCI Members

Start Date: 1/31/2017
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $437,878
Total SCG Cost: $25,000
Total Cofunding: $412,878
Benefits:

Eclipse Scientific Red/Green Light Tool for NDE of PE Pipe Butt Fusion Joints – Phase 1-a (M2019-010)

One method of connecting PE pipe to another PE pipe or fitting is by melting both ends and forcing the ends together to form a BF. The integrity of this BF is important for long-term performance. This project will develop an automated NDE red/green light tool to inspect the integrity of BF joints that does not require operators with specialized training in NDE. NYSEARCH members have invested considerable resources into NDE development for PE pipe through extensive testing with The Welding Institute. This testing established pass/fail criteria for BF joints based on extensive empirical testing of good and defective BF joints. This project is currently in the NDE techniques development and optimization phase.

Cofunders: NYSEARCH Members

Start Date: 1/31/2020
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $153,790
Total SCG Cost: $13,670
Total Cofunding: $140,120
Benefits:

EMAT Sensors for Small Diameter and Unpiggable Pipe & Remaining Wall Thickness (4.13.c.2a & 4.13.c.3a)

Many ILI technologies use MFL detection methods to measure wall loss on metallic pipelines due to internal or external corrosion This project was to develop an EMAT sensor for small-diameter unpiggable pipelines that can identify smaller defects than traditional MFL tools. The EMAT sensor can be used to assess the wall thickness of small-diameter, unpiggable pipelines that may have reduced diameter fittings and other restricting features. The sensor can be placed on various robotic platforms to enhance ILI, pipeline integrity, and safety. An 8-inch prototype has been built and is available for testing via a tether (wireline). The vendor is also working on an 8-inch free-swimming tool that should be available for test runs in 2021. SoCalGas values the technology and will evaluate the free-swimming tool for future demonstrations.

Cofunders: PRCI Members, PHMSA, Others

Start Date: 4/1/2018
End Date: 7/17/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $2,059,337
Total SCG Cost: $9,644
Total Cofunding: $2,049,693
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Energy Harvesting for Recharging of Explorer Robotic Platforms PH II (M2016-009)

ILI of metallic pipelines uses a robot to support sensors and travel along the pipeline while navigating through obstacles. Currently, power is provided by onboard batteries that have a limited capacity. The goal is to develop and commercialize an on-board module that extracts energy from the flow of natural gas inside the pipeline and powers the Explorer family of robotic inspection platforms. This would extend the inspection range capabilities of the robots. Phase I focused on the energy extraction module and Phase II is focused on iterations of the power-generating module prototype. In 2019, successful power generation results were achieved in a laboratory flow chamber and with a live pipeline test, and design modifications were identified. In 2020, manufacturing and assembly of a new, redesigned energy harvesting module were completed. The next steps are to complete laboratory testing and draft the final report.

Cofunders: NYSEARCH Members, PHMSA

Start Date: 10/1/2016
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $14,135
Total Project Cost: $1,631,721
Total SCG Cost: $171,265
Total Cofunding: $1,460,456
Benefits:

Energy Harvesting in Gas Industry Applications (M2016-006) – Phase I/II

The project goal is to carry out a feasibility study to identify technologies that generate 3-5 watts of power by harvesting energy from available "background" resources (e.g. vibration, flow, temperature differences, etc.). This would power sensory and related devices in areas where utility power is limited or non-existent and battery power requires periodic replacement. Phase I identified potential technologies. Phase II is evaluating four identified energy harvesting technologies for practicality and commercial availability. Two technologies were selected for further evaluation: thermal energy and fluid flow energy. For the thermal energy method, laboratory testing of thermoelectric generators has been completed. Testing and evaluation of thermal energy and fluid flow energy technologies is still ongoing.

Cofunders: NYSEARCH Members

Start Date: 12/1/2016
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $5,931
Total Project Cost: $293,235
Total SCG Cost: $27,931
Total Cofunding: $265,304
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Fiber Optics Pipeline Integrity Monitoring System at a Creek Bed

SoCalGas installed an optical fiber cable monitoring system adjacent to buried pipelines to evaluate their capability to detect ground movement (subsidence), pipeline strain, third-party intrusion, and rapid temperature changes (e.g., caused by exposure or pipeline gas leakage). The test environment was a creek bed where sections of underground pipeline were exposed during the 2018 rains that caused massive mudslides. For this project, passive monitoring, where the cables are periodically rather than continuously scanned, was conducted. The overall project conclusion was that optical-fiber cables have the potential to be an option for long-term monitoring of pipelines buried under waterways. The next step is to implement active monitoring of the cables. Cables are continuously scanned during active monitoring and operators receive alarms when the cables detect strain/movement or rapid temperature changes that could indicate abnormal conditions on or in the vicinity of the pipeline and possible pipeline damage. This project was remapped from the Environmental & Safety.

Cofunders: N/A

Start Date: 1/1/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $26,253
Total Project Cost: $530,000
Total SCG Cost: $530,000
Total Cofunding: $0
Benefits:

Fracture Toughness via in-Ditch Non-Destructive Testing-Validation (NDE-2-9)

The project established the relationship between new NDE test measurements and established standardized tests for fracture toughness. The research validated a new technology that determines material fracture toughness through in-ditch NDE testing. The data was combined with the "binning" of pipe joints that is currently performed using in-line inspection tools, which reduced the need to perform costly cutouts and associated shutdown of the pipelines for laboratory Charpy-V notch tests. SoCalGas currently uses the developed in-ditch tool for pipe grade and will use its newly developed capability to measure fracture toughness.

Cofunders: PRCI Members

Start Date: 10/23/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $149,270
Total SCG Cost: $4,972
Total Cofunding: $144,298
Benefits:

ILI Crack Tool Reliability and Performance Evaluation (NDE-4-7)

This project sought to improve statistical modeling based on updated ILI/NDE data to characterize ILI tool crack detection and sizing performance with respect to rate of detection, probability of identification, false discovery rate, and sizing accuracy to reduce the uncertainty of both detected and undetected features. This project expanded industry understanding of the ability of ILI and in-ditch tools to detect, characterize, and size pipeline crack defects. It reviewed industry-wide inspection results and compared them with direct examination results. This improved the understanding of the accuracy and reliability of the inspection tools, and helped vendors improve their processes to provide better inspection remedies. SoCalGas supports industry-wide efforts to improve the detection and characterization of pipeline cracks.

Cofunders: PRCI Members

Start Date: 10/1/2016
End Date: 2/10/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $259,600
Total SCG Cost: $9,811
Total Cofunding: $249,798
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Improve Dent/Cracking Assessment Methods (PHMSA) (MD-5-2)

This project enhances previously developed tools being adopted by API RP 1183, Assessment and Management of Dents in Pipelines. The RP is designed to help maintain the structural integrity of pipelines by addressing mechanical issues. It gives operators the tools needed to help ensure pipeline infrastructure is safe, reliable, and efficient. The project objective is to improve API 1183's ability to support Mechanical Damage integrity assessment and management by: 1) improving indentation crack formation strain estimates; 2) determining the impact of ILI dent and interacting feature sizing variation; and 3) defining dent fatigue life assessment safety factors. The analysis on the dent shape variation impact and the improvement of the indentation crack formation estimates have been completed. The analysis for dent safety factor quantification has begun.

Cofunders: PRCI Members, PHMSA

Start Date: 9/30/2019
End Date: 9/29/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $459,643
Total SCG Cost: $1,546
Total Cofunding: $458,097
Benefits:

ILI Sizing Accuracy (NDE-4-19)

This project involves understanding the probability of detection by ILI of immediate pipeline defect conditions, where the industry aspiration is 100% detection of critical integrity conditions. It is important to understand the probability of identifying immediate conditions to minimize the number of missed defects without increasing the number of false indications, to optimize the number of excavations needed for operation pipeline safety, and to better utilize resources. The literature review supported the development of corrosion profiles for the ILI pull test. The final testing protocols and pipe string requirements are being developed. Pipe samples are in the process of being obtained and prepared for testing.

Cofunders: PRCI Members, PHMSA

Start Date: 9/30/2019
End Date: 9/29/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,251,100
Total SCG Cost: $5,000
Total Cofunding: $2,246,100
Benefits:

InSAR Monitoring of Pipeline Geohazards in Vegetated and Very Large Non-Vegetated Areas (GHZ-2-03, GHZ-2-03&A)

Approximately 8% of pipeline incidents are related to geohazards, and these incidents often result in devastating consequences. InSAR is a satellite-based remote sensing technology that can help detect and monitor geohazards across large geographic areas to reduce risk. This project assessed the utility of InSAR in the identification of previously unknown regions of ground displacement, monitoring of known geohazards, design and planning phase of pipeline construction, and tracking of longwall mining related (or similar) subsidence in or near pipeline corridors. Phase I of the project was completed. Phase II is ongoing with InSAR Geohazard Monitoring of Pipeline ROWs in the Appalachian Mountains. This project will produce an ongoing data set with monthly updates to identify areas of ground movement along the ROW using the remote satellite technology. The vendor will deliver two comprehensive reports per year that will contain time series charts of displacement for each data point over the duration of the project. Ground truth validation data for third-party encroachment will be performed. The final report is expected in early 2021.

Cofunders: PRCI Members

Start Date: 1/1/2019
End Date: 7/8/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $253,228
Total SCG Cost: $14,950
Total Cofunding: $238,278
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Integrity of Crack Colonies with the Aid of Advances in Nondestructive Evaluation including EMAT and Ultrasonic Imaging (NDE-4-10)

Using ILI tools is more cost-effective and less disruptive than hydrotesting and provides the ability to measure pipeline anomalies before they become defects that cause pipeline failures. However, limitations of current ILI technologies require pipeline operators to make conservative assumptions regarding the "effective crack length," which is used for failure-pressure calculations. Failure-pressure calculations based on these conservative assumptions can result in unnecessary digs and repairs. This project developed and validated methods for obtaining more accurate estimates for effective crack length, and resulting failure pressure calculations, using EMAT ILI and ultrasonic imaging technology. This project successfully demonstrated a general approach for improving crack ILI technology using field NDE methods.

Cofunders: PRCI Members

Start Date: 2/1/2017
End Date: 7/17/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $750,000
Total SCG Cost: $0
Total Cofunding: $750,000
Benefits:

Methodology for Assessing Seam Weld Anomalies Using In-Line Inspection Data – Phase I (SCC-6-3)

The project used PRCI member ILI data to develop a shared knowledge base and systematic approach that benefits all operators and allows all crack ILI tools to be used more appropriately. Many operators have inspected pipelines and, especially where seam weld or manufacturing defects exist, the ILI tools can report a large number of anomalies. Using conventional conservative methods of analyzing these as cracks, it would appear that many of the anomalies are injurious; however, when operators have tested these in the lab, the burst pressures indicate the capacity has not been compromised. If these investigations are collated and categorized, a set of approaches can be developed for each category. Phase I developed a process for integrity management of seam weld anomalies using ILI data from operators and laboratory test validation. The Final Report was issued. This project was remapped from the System Design & Materials subprogram.

Cofunders: PRCI Members

Start Date: 1/1/2016
End Date: 1/5/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $236,000
Total SCG Cost: $4,374
Total Cofunding: $231,626
Benefits:

Modeling and Assessing PE Assets with 3D Scanning Technology

The objective of this project is to evaluate different use cases for 3D scanning technology, particularly modeling PE fittings and PE failures to support the failure analysis process. SoCalGas has identified the following potential use cases: model components where manufacturer drawings are not readily available, model pipe or fittings in-situ, and model failures as an alternative to destructive testing.

Cofunders: N/A

Start Date: 10/30/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $8,589
Total Project Cost: $23,589
Total SCG Cost: $23,589
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Modernize of the River X Software (ENV-4-1)

Aboveground pipelines that bridge river crossings may experience high stress/strain loads due to free spans and may encounter vortex-shedding-induced oscillations caused by river flow against the pipe span that could lead to fatigue failure. This project updated the River X software widely used in the industry for integrity assessment of aboveground pipelines bridging river crossings. The goal was to improve assessment time by providing information immediately for operational decisions. The software methodology considers hydrodynamic and debris loading, screening/allowable free spans, and VIV fatigue loading. The bugs in the existing software were fixed and the addition of advanced calculations were implemented. SoCalGas will use this program to evaluate pipelines that become exposed in riverways to determine whether SoCalGas will need to immediately replace or lower these crossings.

Cofunders: PRCI Members

Start Date: 1/31/2017
End Date: 1/6/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $282,209
Total SCG Cost: $46,620
Total Cofunding: $235,589
Benefits:

Modernize the Assessment of Pipeline Water Crossings (ENV-4-1A)

The project goal is to improve the capabilities of existing streamflow monitoring techniques, as well as engineering assessment and risk tools used for managing the integrity of pipeline crossings over waterways and the planning of new crossings. Tasks will include field verification of scour and erosion prediction for hydrology, hydraulics, and fluvial geomorphology; field validation of VIV initiation within waterways for pipeline limitations and VIV avoidance criteria; and building and testing of a prototype website-based alerts dashboard. This project may allow operators to determine which crossings require operational (e.g., monitoring) or engineering (e.g., mitigation) controls to lower the probability of future flooding hazards that can lead to containment loss, and to screen locations for future crossings. The results can supplement guidance for API RP 1133, Managing Hydrotechnical Hazards for Pipelines Located Onshore or Within Coastal Zone Areas. The next major milestones are finalizing the pilot dashboard and monitoring any flood/flow events.

Cofunders: PRCI Members, PHMSA

Start Date: 1/1/2019
End Date: 11/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $740,035
Total SCG Cost: $24,119
Total Cofunding: $715,916
Benefits:

New Extended Evaluation of Large Stand Off Magnetometry (NDE-3-4)

A major hurdle for the natural gas industry is to confirm the integrity of 'challenging-to-inspect' pipelines and flow lines (e.g., both onshore and offshore) where the internal insertion of a tool is not possible. Numerous stakeholders, including regulators, are demanding greater assurances of system integrity. For onshore applications, standoff methods will either simplify or avoid excavation altogether. This project assessed the science behind LSM, which included aboveground assessment of pipeline conditions, without applied magnetic fields, and physical cause analysis. The deliverable was a report on the evaluation on LSM technologies and the purpose of the project was to establish the ability of LSM to detect corrosion in API 5L pipe grades B to X70. The results gathered from NDE-3-4 will continue for NDE-3-5 which investigates the ability of LSM to detect changes in stress in metal piping.

Cofunders: PRCI Members

Start Date: 4/18/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $537,001
Total SCG Cost: $35,424
Total Cofunding: $501,577
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

NJIT Advanced Terahertz (THz) Imaging & Spectroscopy for Non-Destructive Evaluation of Polyethylene Pipes (M2018-009 PHII)

Integrity assessment of PE pipe BF joints has typically been performed via a visual inspection. Technology advancements may be useful for assessing the quality of questionable BF joints and may prevent unnecessary cutout of good BF joints with the appearances of a bad fusion. The objective of this research program is to continue the development of THz time-domain spectroscopy and imaging for the nondestructive evaluation of PE gas pipeline BF joints. Based on the analysis of preliminary samples that are not made to a specific standard, the Phase 1 feasibility study confirmed the general ability of THz to detect defects in PE pipe BF joints. Phase 2 will further evaluate the THz capability on BF joint samples that have inclusions at the acceptance criteria threshold. This project is currently awaiting defective BF samples, which were made to specific standards developed by The Welding Institute. The first batch of defective BF samples is expected to arrive in the first quarter of 2021.

Cofunders: NYSEARCH Members

Start Date: 7/1/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $49,580
Total Project Cost: $583,166
Total SCG Cost: $49,580
Total Cofunding: $533,586
Benefits:

Numerical Modeling and Full-Scale Testing to Evaluate the Performance of Large Standoff Magnetometry (NDE-3-5)

This project builds upon the research performed in NDE-3-4. The purpose of the research program is to evaluate the performance of LSM technology for pipeline integrity inspections using a test rig that introduces various combinations of loading into a pipe sample, including internal pressure, axial tension/compression, and bending. The intent is to introduce loading representative of what might be encountered in a geohazard condition. The challenge with the current state-of-the-art LSM technology is the lack of validation data and fundamental research to support the use of LSM technology. In addition to the full-scale testing, this project integrates a phase of work involving numerical modeling and laboratory testing. Once this project is completed, pipeline operators are expected to have a better understanding of the range of measurement capabilities associated with current LSM technology; allowing them to decide the best means for deploying this into the field. A literature review of magnetic sensor technologies and commercially available products has been completed. The next task will be to perform testing.

Cofunders: PRCI Members, Technology Providers

Start Date: 6/12/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $5,000
Total Project Cost: $192,308
Total SCG Cost: $24,434
Total Cofunding: $167,874
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Optimal Approach to Cost Effective, Multi-source, Satellite Surveillance of River Crossings, Slope Movements and Land Use Threats to Buried Pipelines (GHZ-2-02)

Regulations require pipeline operators to mitigate geohazard and land use threats to pipeline integrity, particularly on slopes near river and stream crossings. In addition to applicable regulatory requirements, detecting and mitigating geohazard motion and ROW land use encroachment threats are primary elements of pipeline operators' damage prevention strategies and programs. This project intends to develop improved methods for satellite-based tools and technologies to enhance detection of natural changes, seasonal flooding, erosional effects, channel dynamics, and ground movement affecting pipelines installed near river crossings. Successful completion of this project will identify three leading classes of satellites available in the market to support pipeline integrity programs, enhance operators' risk mitigation programs through more frequent high-resolution detection of risk factors, and ROW surveillance. Data collection is underway and field verifications have been planned.

Cofunders: PRCI Members

Start Date: 1/31/2018
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $330,814
Total SCG Cost: $10,267
Total Cofunding: $320,547
Benefits:

Performance Capabilities Evaluation of ILI for Long Seam Features in ERW Pipe (IM-3-1)

The objective of this project was to provide performance data for ILI technologies used to identify and characterize anomalies in the longitudinal seam of ERW pipe. The project produced performance qualification data of ILI technologies for detecting and sizing features, anomalies, and defects in long seams. The results obtained from this project are promising and are the beginnings of ILI specifications for the detection, identification, and sizing of ERW features. The project results helped ILI service providers to offer better inspection remedies for detecting and sizing ERW seam anomalies.

Cofunders: PRCI Members

Start Date: 7/1/2017
End Date: 7/13/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $707,000
Total SCG Cost: $15,000
Total Cofunding: $692,000
Benefits:

Performance Evaluation of ILI Systems for Detecting and Discriminating Metal Loss, Cracks, and Gouges in Geometric Anomalies (MD-1-13)

PRCI's MD program focused on the development of models that allowed the user to understand the failure mechanisms associated with plain dents, gouges, and dents associated with welds. These models use feature characterization (e.g., dent physical shape, length, width and depth, etc.) and strain measurements as input data for the analysis of the effects of MD features on pipeline integrity. The project has been completed with the final report, a study of ILI systems on MD. The results will be used to define performance and report specifications for ILI system to MD, which is a gap to any industry accepted standard or specification. Additional work in this area will be performed under NDE-4-18.

Cofunders: PRCI Members

Start Date: 9/28/2018
End Date: 11/23/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $1,387,543
Total SCG Cost: $17,673
Total Cofunding: $1,369,870
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Remaining Life Model and Assessment Tool for Dents and Gouges (MD-4-16)

The objective of this project is to produce a level 1-2 assessment model to analyze fatigue crack growth and predict fatigue life of MD from dents and gouges caused by cyclic pipeline operating pressures. The desired outcome of this project is the ability to manage the threat of dents and gouges in pipelines in a prioritized manner and reduce overall cost. The outcome is intended to bridge a current gap in the ability to quantitatively assess fatigue life at dents and gouges in pipelines. The deliverable will be a computer-based assessment tool that will interpret and screen ILI and NDE data. To date, a technical literature review to identify gaps and an initial model algorithm confirming feasibility have been completed. The next task is to finalize algorithms for crack driving force and resistance models to be used in the future PC-based assessment tool.

Cofunders: PRCI Members

Start Date: 2/4/2019
End Date: 8/8/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $351,232
Total SCG Cost: $4,679
Total Cofunding: $346,553
Benefits:

Remote Monitoring of Pipe-to-Soil Readings, AMI Network Integration (5.21.g)

Gas utilities are required by federal regulations to perform periodic monitoring on the CP system for their steel pipelines. The monitoring requires technicians to manually take P2S voltage measurements at specific locations, some in remote areas, to assess the effectiveness of their CP system and determine if mitigative measures are needed to correct abnormal conditions. There are commercial P2S monitoring systems that use cellular communications to transmit data from remote locations. This project will assess the use of an existing utility's AMI communication system/LoRaWan network to decrease the labor cost of monitoring the CP system. The technology will also offer utilities the capability to perform monitoring of their CP systems more frequently. The project plans to set-up the network and measuring device at GTI or a member utility facility for testing. A final report intended to provide procedures for integrating a remote CP monitoring system with an AMI/LoRaWan network will be prepared.

Cofunders: OTD Members

Start Date: 1/31/2021
End Date: 4/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $157,000
Total SCG Cost: $15,000
Total Cofunding: $142,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Selective Seam Weld Corrosion Detection with In-Line Inspection Technologies (NDE-4-13)

Pipeline integrity management for pipelines that have corrosion interacting with the long seam weld can be challenging. Circumferential MFL technologies can detect the long seam weld position and report accurately if corrosion interacts with the long seam. Generally, these tools are not able to differentiate if there is SSWC on the long seam. As technologies and analysis processes have improved, ILI providers are having success with detecting SSWC. The expected benefit of this project is to provide pipeline operators with the ability to make informed decisions for managing a pipeline with SSWC or corrosion. The expected result of this project is to provide users with the knowledge of current ILI capability in detecting SSWC and differentiating SSWC from coincidental corrosion that interacts with the long seam weld. PRCI is currently engaged in documenting experience, collecting samples, and researching defect manufacturing.

Cofunders: PRCI Members

Start Date: 10/6/2020
End Date: 9/30/2022
Status: Active
2020 Funds Expended: $3,655
Total Project Cost: $770,000
Total SCG Cost: $3,655
Total Cofunding: $766,345
Benefits:

Small Diameter Acoustic Resonance (ART) ILI Tool Feasibility Study and Concept Design (NDE-4-15)

The project assessed the use of ART in small-diameter pipelines. ART was developed for in-line inspection of larger, 16-inch to 48-inch diameter, heavy-wall gas and waxy liquid pipelines. The goals of this project were to provide a detailed technical understanding of the challenges with inspecting the given pipeline sizes, to evaluate present ART Scan system components against identified challenges, and to concept-engineer a new design meeting the technical requirements of small diameter pipelines. This feasibility study showed that the ART Scan technology can be miniaturized and packaged to suit small-bore pipelines. The concept portrayed in this feasibility study is expected to lead to tool development by the technology provider.

Cofunders: PRCI Members

Start Date: 11/1/2018
End Date: 5/1/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $210,040
Total SCG Cost: $10,000
Total Cofunding: $200,040
Benefits:

Standard Library of PE Joint Samples with Embedded Defects for NDE Tool Validation – Phase I-a (M2019-009)

The objective of this program is to produce a PE pipe BF joint sample library with known defects that can be used to validate current and future NDE technologies claiming to be capable of detecting PE butt fusion defects applicable to the gas industry. NYSEARCH members have invested considerable resources into NDE development through extensive testing with The Welding Institute. A sample library will provide a resource to validate any NDE tool purported to be capable of identifying defects that would impact the integrity of BF joints. In 2020, the raw materials were obtained, and butt-fusion fabrication procedures were sent for sponsor review. The first batch of defective butt-fusion joint samples are expected to be ready first quarter 2021.

Cofunders: NYSEARCH Members

Start Date: 10/10/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $1,465
Total Project Cost: $545,200
Total SCG Cost: $48,465
Total Cofunding: $496,735
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Structured Light Scanning Tool for Distribution Pipeline Inspection – Phase 1 (4.18.a)

The project objective was to advance the proof of concept and develop a structured-light scanning tool for internal inspection of plastic and metallic pipes. Inspection of internal pipe geometry and surface conditions of distribution mains provides operators with knowledge of joints, laterals, etc., which are difficult to detect with current technologies. The inspection of the plastic pipe inner wall surface condition is important to monitor deformations caused by pipe squeeze-off operations, which have been shown to be the main cause of stress-induced slow crack growth in plastic pipes. In this project, researchers investigated a structured light sensor that can reconstruct the profiles of the internal pipe surface and detect the existence of deformations and defects and developed a lab prototype of the tool. Another phase of the project is anticipated to further the development of the tool.

Cofunders: OTD Members, PHMSA

Start Date: 7/1/2018
End Date: 8/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $1,875
Total Cofunding: $148,125
Benefits:

Technology Development Center (TDC-1-1 & 1-A)

The project provides support for the new PRCI TDC in Houston, Texas, which opened in the summer of 2015. The TDC is the result of a major commitment by the energy pipeline industry to address the key issues the industry is facing to ensure the safety and integrity of the vital national and international steel pipeline infrastructure. The TDC provides the industry with an independent third-party site to fully understand the capabilities of current pipeline inspection tools and to guide the development of new technologies needed to push toward the pipeline safety and integrity goal. The TDC enables efficient and timely access to industry samples in support of technology projects and programs.

Cofunders: PRCI Members

Start Date: 1/1/2015
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,440,727
Total SCG Cost: $42,709
Total Cofunding: $3,398,018
Benefits:

Unmanned Aerial System RD&D

Aviation Services—a division within Gas Operations—assessed the aerial imagery potential of UAS photography in both difficult-to-access and demanding environments. Obstacle sensing capabilities, dim lighting photography, potential satellite interference, remote videography, and data handling are among the complex situations addressed. Service areas included residential MSA with hindered access, a supply line inspection in the dimly lit environment under a steel-reinforced concrete bridge spanning the Los Angeles River, and video production of a virtual "job walk" along Line 1008A in Central California. Further evaluation of ground survey technology utilizing Light Detection and Ranging, a state-of-the-art 3D mapping tool, was delayed due to COVID-19-induced resource constraints.

Cofunders: N/A

Start Date: 1/1/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $25,135
Total Project Cost: $440,248
Total SCG Cost: $440,248
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Validate ILI Capabilities to Detect/ Characterize Mechanical Damage (PHMSA) (NDE-4-18)

This project expands the current state of knowledge for ILI system performance to detect and characterize corrosion, welds, gouges, and crack features interacting with dents. The objectives of this study are to develop representative interacting features that will be used to provide an understanding of current ILI tool performance and support improvements in ILI system performance and specifications. The project will generate data supporting the development of revised dent response criteria being pursued in PRCI R&D projects and address recommendations issued to PHMSA by the National Transportation Safety Board to promulgate new regulations that address dent-acceptance criteria. For the PHMSA co-funded work, progress continues to fabricate dent specimens.

Cofunders: PRCI Members, PHMSA, Others

Start Date: 9/30/2019
End Date: 3/21/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,012,542
Total SCG Cost: $25,722
Total Cofunding: $2,986,820
Benefits:

Validating Non-Destructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry (4.14.c.2)

The project objective is to facilitate the use of non-destructive surface testing—including micro-indentation, micro-machining, in-situ chemistry, and replicate microscopy analysis—as accurate, efficient, and cost-effective tools for material property confirmation on steel pipe. This work is intended to provide benefits to pipeline safety, energy continuity, and integrity assessment programs because the developed techniques, models, and validated testing technology will not require a line to be taken out of service or destructively cut out samples from an in-service pipeline. The results of this project are also intended to apply to pending DOT/PHMSA regulations that require operators to backfill their material property records for grandfathered pipeline segments and/or those that do not have adequate material records. In 2020, non-destructive evaluation Toughness Testing of 30 pipe coupon samples and data analysis was conducted, and model generalization and optimization were completed. The final report and implementation guide are being prepared.

Cofunders: OTD Members, DOT/PHMSA, Others

Start Date: 9/3/2018
End Date: 6/7/2021
Status: Active
2020 Funds Expended: $17,687
Total Project Cost: $1,054,516
Total SCG Cost: $57,874
Total Cofunding: $996,642
Benefits:

Validation of NDT Technology for PE Pipe (5.20.p)

This project will evaluate and validate the claims of commercially available NDT technologies for PE pipe and fitting joints. This evaluation will include heat fusion (e.g., butt and sidewall) and electrofusion (e.g., couplings, branch fittings, service tees, etc.) pipe joining methods. It is imperative that industry understands the capabilities and limitations of these different NDT technologies to determine whether the technologies are reliable for determining joint integrity. A Final Report will include potential technology enhancements. The project was kicked off in early December 2020. Sponsor feedback was obtained for the materials and sizes that will need to be tested during the first year of the project.

Cofunders: OTD Members

Start Date: 10/1/2020
End Date: 1/31/2022
Status: Active
2020 Funds Expended: $11,000
Total Project Cost: $200,000
Total SCG Cost: $17,054
Total Cofunding: $182,946
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Xray and Terahertz Development for NDE of PE Pipe by Iowa State University (M2019-007 Phase II)

In Phase 1, the team conducted a feasibility study of using radiography and CT for inspecting plastic pipelines used in the natural gas industry. Plastic pipes and BF joints with different types of defects were evaluated using X-ray radiography and CT. The results from Phase 1 demonstrated the capability of X-ray radiography for PE pipe inspection and paved the way to optimize a portable X-ray system in future phases of the project. X-ray radiography and CT were shown to be complementary to THz methods in different aspects of PE pipe inspections. The objective of Phase II is to advance Iowa State University THz and X-ray NDE technologies with enhanced techniques that can interpret PE BF joint defects with 2D and 3D reconstruction imaging. THz and X-ray contour-following fixture construction will be performed, and defective BF samples will be developed and used for scanning, evaluating, and further developing the 2D and 3D scan data interpretation for each defect type. This project has just commenced, and the development is in progress.

Cofunders: NYSEARCH Members

Start Date: 1/20/2021
End Date: 1/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $394,494
Total SCG Cost: $45,400
Total Cofunding: $349,094
Benefits:

Reliability

Safety

Operational Efficiency

Improved Affordability

Environmental: Reduced GHG Emissions

Environmental: Improved Air Quality

CLEAN TRANSPORTATION

SUBPROGRAM: OFF-ROAD

GTI Doosan Hydrogen Drone Demonstration

The project will demonstrate Doosan Mobility Innovation's (DMI) hydrogen drone technology to assess DMI's hydrogen infrastructure plans, with specific focus on fueling sites and repair/maintenance facilities for fuel cell drone operations. The project will include a review of: 1) DMI-generated documentation, including the Operational Safety Plan and procedures related to handling, storage, fueling, and training protocols for DMI personnel; and 2) pertinent codes and standards, including CFR 49 as it relates to transport/storage of compressed hydrogen gas via a mobile application; NFPA2, Los Angeles County codes, and latest IFC as it applies to compressed hydrogen gas used/stored in exterior, non-fixed systems. GTI will also support access to fueling the drones at hydrogen fueling stations in Southern California and Austin, Texas or by other means. It is likely that the drone pressure vessels or a hydrogen trailer utilized for fueling the drone pressure vessels will not be suitable to commercial fueling stations, so GTI may need to determine a fueling method. GTI will provide safety protocols for fueling at the hydrogen stations or by other means.

Cofunders: N/A

Start Date: 9/30/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $250,000
Total SCG Cost: $250,000
Total Cofunding: $0
Benefits:

Michael Naylor On-Board CNG Storage for Construction Equipment Market Survey

This project addressed the competitive and regulatory pressures that diesel fleet owners are facing to meet Tier 4 emissions standards for heavy-duty off-road vehicles. The project surveyed construction fleets in the South Coast Air Basin and engaged engineering groups to discover the technical requirements for retrofitting diesel engines to CNG for construction equipment. New diesel engines manufactured in the United States for construction vehicles such as wheel tractor-scrapers, wheel dozers, excavators, and wheel loaders are required to meet the Environmental Protection Agency (EPA) Tier 4 off-road standard of approximately 0.3 grams per brake horsepower hour (gr/bhp-hr) for nitrogen oxides (NO_x). In California, regulatory and competitive pressures are motivating fleet owners to convert their older (Tier 3 or less) machines to Tier 4. Most older machines cannot be repowered (replace older engine with new one) to Tier 4 because the manufacturer does not have a Tier 4 retrofit package. Consequently, those machines need to be replaced with current model machines to meet the Tier 4 goal.

Cofunders: N/A

Start Date: 11/19/2019
End Date: 3/31/2020
Status: Completed
2020 Funds Expended: $18,291
Total Project Cost: $38,807
Total SCG Cost: $38,807
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: ONBOARD STORAGE

GNA Tri-Generation Feasibility Phase 1 Assessment

The goal of this project is to analyze the potential economic case for the use of a high-temperature fuel cell to produce electricity and hydrogen from renewable natural gas delivered by the SCG pipeline for transportation applications. This "tri-generation" system is based on the FuelCellEnergy SureSource 3000 molten carbonate fuel cell system that produces up to 3,000 kW gross DC output and 1,270 kg/day of hydrogen production. The system additionally produces 0.5 MMBTU/hour of thermal output. However, for the purposes of this analysis, use of the thermal energy is not considered.

Cofunders: N/A

Start Date: 6/30/2018
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $11,971
Total Project Cost: $48,000
Total SCG Cost: $48,000
Total Cofunding: $0
Benefits:

Ingevity ANGP Ford F-150 Medium Duty Truck Demonstration

The proposed project was to research, develop, and demonstrate a proof of concept of low-pressure storage of 1) low-grade renewable natural gas (RNG) and 2) high-grade natural gas enriched with renewable hydrogen, on an automotive adsorbed natural gas (ANG) tank. The low-pressure ANG technology is a young technology and sensitive to gas quality. Low-quality natural gas, such as unconditioned biogas, can "poison" the carbon monolith material inside ANG tanks, resulting in an unrecoverable reduction in tank efficiency. The project established a benchmark and foundation for successful operation of the tank (adsorbent, pressure, temperature) for multiple fuels.

Cofunders: N/A

Start Date: 10/16/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $250,000
Total SCG Cost: $250,000
Total Cofunding: $0
Benefits:

Sandia National Labs Metal Hydride Composite Hydrogen Storage for Heavy Duty Vehicles

The proposed project is to evaluate metal hydride composites as a materials-based storage medium to replace high-pressure hydrogen gas storage on Class 7 and 8 heavy-duty fuel cell electric trucks. The thermodynamic and kinetic properties of metal hydrides allow them to fully regenerate following hydrogen desorption at pressures much lower than 700 bar. For example, metal amides that will be considered in this project can be regenerated at 100 bar, much lower than current onboard high-pressure hydrogen storage tanks (350 or 700 bar). Using lower-pressure hydrogen could translate into more efficient storage tank designs that weigh and cost less than current high-pressure steel hydrogen storage tanks. Low-pressure hydrogen for vehicles can also increase reliability and reduce compression costs at refueling stations by utilizing lower pressure compressors. An additional benefit is that knowledge generated by this project could assist in development of material-based storage for stationary applications such as microgrids and backup power for data centers.

Cofunders: N/A

Start Date: 11/30/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $375,000
Total Project Cost: $375,000
Total SCG Cost: $375,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Modular CNG Storage System Investigation (2.15.H)

The objective of this project is to investigate the status as well as the code and certification needs and solutions of various conformable storage systems being developed across the industry. As a result, four companies were identified that are either currently developing conformable CNG storage tanks or have developed them significantly in the past and are still looking for customers, applications, and development partners. CNG fuel tank developers have made a lot of progress, but there are still technical barriers hindering their success.

Cofunders: UTD Members, CSA, ARPA-E

Start Date: 6/1/2015
End Date: 4/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $281,925
Total SCG Cost: $10,000
Total Cofunding: $200,000
Benefits:

SUBPROGRAM: ON-ROAD

CALSTART Class 8 Hydrogen Fuel Cell Truck Commercialization Roadmap

The proposed project will develop two roadmaps, a Technology Commercialization Roadmap and a Medium- and Heavy-Duty (MD/HD) Hydrogen Fueling and Infrastructure Roadmap to supplement and support Cummins' Hydrogen Fuel Cell Class 8 Truck deployment and demonstration for drayage and regional delivery project funded in part by the CEC. The Technology Commercialization Roadmap will provide market projections and describe market scenarios for the new truck technology. It will also compare fuel cell trucks to equivalent battery-electric vehicles to explore differences in cost, emissions, performance, and operational success. The MD/HD hydrogen refueling and infrastructure road map will provide recommendations for strategically locating hydrogen fueling infrastructure and estimate future hydrogen demand for the medium- and heavy-duty trucking industry. It will also analyze the viability of various hydrogen production and delivery pathways, comparing centralized production with trucked hydrogen, pipeline delivery of hydrogen, and distributed/onsite production.

Cofunders: N/A

Start Date: 4/30/2020
End Date: 4/30/2022
Status: Active
2020 Funds Expended: $25,000
Total Project Cost: $216,000
Total SCG Cost: $216,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

CALSTART CNG Hybrid Class 8 Truck Demonstration

This study was part of a larger California Energy Commission project for Kenworth Truck Company that identified the business case for electric heavy-duty trucks with range extenders. The study also identified the roll-out plan, early adopters of near-zero-emission heavy-duty trucks, and plans for expansion into other applications. This study updated findings from CALSTART's "Near Zero-Emission Heavy-duty Truck Commercialization Study" in 2014 and provided a comprehensive analysis of how the drayage truck market may look by 2035 depending on how a variety of factors play out. As part of the technology demonstration of the CEC project, CALSTART worked with BAE Systems and Kenworth to demonstrate the performance of a CNG Plug-In Hybrid Electric Drayage Truck. CALSTART also developed a drayage commercialization roadmap to enhance the attractiveness of advanced CNG vehicles as a low-carbon transportation option.

Cofunders: SCAQMD, Contractor, DOE

Start Date: 6/16/2015
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $135,000
Total Project Cost: $20,259,820
Total SCG Cost: $250,000
Total Cofunding: $20,009,820
Benefits:

GTI CNG Plug-In Class 8 Hybrid Truck Development and Demonstration

The goal of this project is to develop and demonstrate a more efficient and optimized energy management platform and controls for natural gas, plug-in, hybrid-electric Class 8 trucks. The Class 8 truck will have improved engine management and controls to optimize fuel economy, extending the range and reducing the GHG emissions.

Cofunders: CEC, CWI, FEV, US Hybrid

Start Date: 11/1/2019
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $64,500
Total Project Cost: $161,250
Total SCG Cost: $161,250
Total Cofunding: $1,338,131
Benefits:

GTI Hydrogen Fuel Cell Yard Truck Port of Los Angeles Demonstration

The objective of the proposed yard truck deployment is to develop and demonstrate the reliability, performance, durability and total cost of ownership of a yard truck fleet in operation at the Port of Los Angeles. This deployment and demonstration is the first of its kind and will pave the way for similar future technologies in this space. Hydrogen Fuel Cell Vehicles have been gaining attention in the transportation space as manufacturers and legislatures look for alternative fuels and technologies to help California meet its greenhouse gas, criteria air pollutant, and toxic air contaminant emissions reductions goals for freight movement. There will be an extensive technology showcase effort to maximize the impact of the demonstration. Yard trucks are the single largest source of emissions in all classifications of cargo handling equipment. The project is intended to demonstrate to port terminal operators that fuel cell powered, zero-emission yard trucks are a safe, reliable, and operationally preferable solution to meet the port's clean air action plan.

Cofunders: CARB, BAE, Ballard, Others

Start Date: 1/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $91,498
Total Project Cost: $12,055,413
Total SCG Cost: $322,500
Total Cofunding: $11,732,913
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SCAQMD and WVU Alternative Fuel Vehicle Maintenance Study

The proposed project will study maintenance-related efforts and costs of heavy- and medium-duty vehicle engines fueled by natural gas, propane, electricity, and high biodiesel blends across different vocations and compare them to conventional diesel vehicles. This maintenance cost assessment will study the link between operational characteristics of alternative fuel vehicles and how they affect maintenance and repair activity. West Virginia University will perform a comparative evaluation of vehicle maintenance costs between natural gas and diesel fueled vehicles. The vehicles in the proposed study include Class 6, 7, and 8 vehicles in the South Coast Air Basin and are used in goods movement and delivery vocations. The project proposes to build upon the emissions and activity data collected and relationships developed in an ongoing in-use emissions study that includes a comprehensive sample of more than 200 trucks and buses from 25 fleet participants in five different vocations. The proposed project will enable correlation of vehicle maintenance costs to already available fleet information, real-world vehicle activity, and in-use emissions data.

Cofunders: SCAQMD, DOE

Start Date: 1/1/2020
End Date: 12/31/2023
Status: Active
2020 Funds Expended: $150,000
Total Project Cost: $1,150,000
Total SCG Cost: $150,000
Total Cofunding: $1,000,000
Benefits:

SCAQMD Commercial Zero Emission Vehicle Roadmap

The SCAQMD Commercial Zero Emission Vehicle (ComZEV) Roadmap project developed a detailed technology- and economics-based roadmap for the adoption of advanced commercial vehicle technologies to reduce NOx and GHG emissions through 2050, with emphasis on the years 2023 and 2032, corresponding to the federal Clean Air Act (CAA) 8-hour ozone standards attainment deadlines. The SCAQMD ComZEV study focused on identifying barriers and opportunities to match advanced technology options to key commercial medium- and heavy-duty vehicle vocations in Southern California. Technology options evaluated included: battery electric vehicles, fuel cell vehicles, catenary/induction electric propulsion systems, and CNG and LNG internal combustion engines and gas turbines. The project evaluated the resulting impact on fleet emissions, vehicle acquisition and operating costs for different scenarios, including, for example, market impacts resulting from different types of incentives and mandates.

Cofunders: SCAQMD

Start Date: 7/1/2015
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $500,000
Total SCG Cost: $250,000
Total Cofunding: $250,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SCAQMD Ford 7.3L Near-Zero Emission Engine Development

This project seeks to develop and commercialize the Ford 7.3L CNG NZE Engine for medium-duty trucks. Three developers—Landi Renzo, Agility Power Systems, and A-1 Alternative Fuels—will develop a CNG NZE variant of the Ford 7.3L CNG engine for medium-duty trucks. Widely untapped, the medium-duty truck market has not seen any near-zero emission engines available other than the Cummins Westport, Inc. ISB 6.7 engine. The 7.3L engine will be calibrated and certified to 0.02 g/bhp-hr NOx, on par with CWI L9N and ISX12N for heavy duty. These will be the first engines in the medium-duty class to reach near-zero emissions and will be widely adopted into Ford medium-duty truck platforms.

Cofunders: US Gain, Ford, SCAQMD, Landi Renzo, Agility Fuel Systems (CNG), Agility Fuel Systems (LPG)

Start Date: 11/30/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $300,000
Total Project Cost: $4,379,747
Total SCG Cost: $900,000
Total Cofunding: $3,479,747
Benefits:

SCAQMD Heavy Duty Truck Engine In-Use Emission Study

Assessment of in-use emissions from heavy-duty vehicles remains a critical component of measuring the effectiveness of engine, fuel, and aftertreatment technologies as well as the South Coast Air Basin's progress toward achieving federal ambient air quality standards. The project team will conduct in-use emissions testing, fuel usage profile characterization, and an impact assessment of current technology and alternative fuels on fuel consumption and in-use emissions from heavy-duty vehicles in various vocations.

Cofunders: CEC, CARB, SCAQMD

Start Date: 11/1/2015
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,285,000
Total SCG Cost: $500,000
Total Cofunding: $2,785,000
Benefits:

SCAQMD Hydrogen Blended Natural Gas in NZE Engine Emissions Study

The project will assess the criteria pollutant and GHG impacts of hydrogen/natural gas fuel blends on near-zero-NOx-emission, heavy-duty natural gas engines. Past studies have shown that the addition of hydrogen in natural gas may result in lower engine emissions when combined with optimized engine calibration. UCR/CE-CERT will design and build an HCNG blending apparatus as part of the study and vary hydrogen content from zero to five percent by volume. The proposed first phase study will focus on the emissions impacts of HCNG blends compared to the baseline on regulated engine test duty cycles. CWI will provide the test engine and aftertreatment systems, as well as engineering and data analysis support, including oil sample analysis. A 2005 comprehensive study conducted by the NREL showed an HCNG fueled engine reduced NOx emissions by 50 percent compared with a CNG-fueled engine in a transit bus application. Recent low carbon and renewable fuel initiatives have renewed interest in further decarbonization of natural gas, providing a source of lower carbon content fuel for the transportation sector.

Cofunders: SCAQMD, Cummins

Start Date: 11/21/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $200,000
Total Project Cost: $534,000
Total SCG Cost: $304,000
Total Cofunding: $230,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SWRI Development of Pent-Roof Natural Gas Engine in an Optimized Hybrid Vehicle System

The project is to develop a pent-roof cylinder head engine for a natural gas engine and integrate it into an optimized hybrid medium duty truck chassis. The pent-roof combustion chamber, or penta engine, is an arrangement of the upper portion of the cylinder and valves that is common in engines using four valves per cylinder. It is similar in concept to the hemi engine, but the hemi engine is limited to only two valves per cylinder. A pent-roof design is an optimum approach for developing a high-efficiency natural gas engine and will provide substantial gains over engine designs that retain the flat head of a diesel engine. The pent-roof design will also enable the use of high levels of EGR dilution to yield a high-efficiency engine that can also easily meet future NOx regulations. To further the vehicle level efficiency gains, a hybrid drivetrain system will be integrated into the truck, thereby also demonstrating a highly optimized low-GHG-emission medium-duty truck.

Cofunders: DOE, SCAQMD, Isuzu, SwRI

Start Date: 6/30/2019
End Date: 12/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $6,049,100
Total SCG Cost: $200,000
Total Cofunding: $5,849,100
Benefits:

SWRI Natural Gas D-EGR Engine for Improved On Highway Efficiency Research and Development

The goal of this project was to obtain a 10% improvement in fuel consumption while achieving 0.02 g/bhp-hr NOx emissions. Continuous improvement in engine efficiency is important to meeting future GHG and near-zero emission regulations. SwRI has investigated a number of technologies to improve spark ignition engine efficiency. D-EGR is a concept where one or more cylinders (likely two in a six cylinder engine or 33%) are used to produce the entirety of the EGR used by an engine. Those cylinders can be run rich to essentially reform fuel, via exothermic partial oxidation, in the cylinder. Therefore, the energy can be captured during expansion which is not possible with an external reformer. The hydrogen produced during reforming can improve burn rates and stabilize combustion with high dilution.

Cofunders: CEC, Woodward

Start Date: 1/1/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $1,141,580
Total SCG Cost: $200,000
Total Cofunding: $941,580
Benefits:

Transient Plasma Systems Advanced Ignition System Testing

The TPI system by TPS is an advanced ignition source that will smooth the adoption of SI NG engines over CI diesel engines. For NG engines to be most easily commercially accepted, they should perform similarly to the diesel truck engines that they replace in terms of efficiency, power, and range, as well as meet emissions requirements with minimal expense and maintenance. Current economic and environmental factors are an incredibly strong incentive to meet these challenges so that the state of California can benefit from this cleaner burning natural resource.

Cofunders: CEC

Start Date: 6/1/2018
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $925,811
Total SCG Cost: $26,672
Total Cofunding: $899,139
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UC Davis STEPS Plus 2020 Program Membership

The Sustainable Transportation Energy Pathways Program at the UC Davis Institute of Transportation Studies is a four-year multidisciplinary research consortium that brings together the world's leading auto and truck OEMs, energy firms, new mobility companies, foundations, and government agencies to understand sustainable vehicle and energy solutions. The STEPS Program focuses on the modeling of transportation/energy systems and assessment of vehicle and energy technologies across multiple transportation sectors to supplement technology research.

Cofunders: N/A

Start Date: 1/1/2019
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $40,000
Total SCG Cost: $40,000
Total Cofunding: $0
Benefits:

UC Davis STEPS Plus 2021 Program Membership

The Sustainable Transportation Energy Pathways Program at the UC Davis Institute of Transportation Studies is a four-year multidisciplinary research consortium that brings together the world's leading auto and truck OEMs, energy firms, new mobility companies, foundations, and government agencies to understand sustainable vehicle and energy solutions. The STEPS Program focuses on the modeling of transportation/energy systems and assessment of vehicle and energy technologies across multiple transportation sectors to supplement technology research.

Cofunders: N/A

Start Date: 1/1/2021
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $80,000
Total Project Cost: $80,000
Total SCG Cost: $80,000
Total Cofunding: $0
Benefits:

UC Riverside Hydrogen Blended Natural Gas Engine Durability Test

The objective of the proposed work is to evaluate the impact of hydrogen content in natural gas on the performance and durability of one end-use technology, specifically the Cummins L9N 8.9 liter near-zero-emission natural gas engine. Cummins has a set limit for hydrogen content of 0.03% by volume, a long-standing limit probably set based on typical natural gas composition. Since the limit is part of the Cummins specification, using natural gas with hydrogen content greater than 0.03% could void the warranty of the engine. The proposed work will provide data that could justify the initiation of extensive validation work to increase the hydrogen limit in the Cummins Fuel Standard.

Cofunders: PG&E

Start Date: 3/6/2020
End Date: 3/6/2021
Status: Active
2020 Funds Expended: $66,000
Total Project Cost: $364,997
Total SCG Cost: $364,997
Total Cofunding: $125,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UCR RNG and HD Truck Pathways to Achieve Climate Goals Study

The objective of this study is to identify the challenges and opportunities to meeting the key energy- and environment-related targets in California relative to the medium/heavy duty transportation sector and to evaluate the optimum pathways towards achieving major air quality, climate, and energy goals, laws, and standards. The project will particularly focus on the potential role RNG can play in this context. The study will inform future RD&D investments in the overlap of the Low Carbon Resources and Clean Transportation sectors.

Cofunders: N/A

Start Date: 11/1/2018
End Date: 3/1/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $100,000
Total SCG Cost: $100,000
Total Cofunding: $0
Benefits:

US Hybrid CNG Plug-In Hybrid Electric Truck Demonstration

The proposed project is to develop and demonstrate an advanced PHET powertrain with an existing Cummins Westport Inc (CWI) L9N NZE CNG engine on a Freightliner Cascadia sleeper-cab truck in a parallel hybrid configuration. The truck will be optimized for over 1,000 miles of total range along with over 600HP to accommodate trucks needing more torque and power, with an all-electric range of 35 miles. The electric motor coupled with the L9N CNG engine will exceed the performance of existing 13-L diesel engines while reducing carbon dioxide and NOx emissions as well as GHG reductions on RNG. The truck will be used as a demonstrator for fleets and events. Emissions and performance analysis will be completed through dynamometer and road-testing to assess the overall advantage and emissions reduction of the PHET design.

Cofunders: SCAQMD, CEC, DOE, US Hybrid, Clean Energy

Start Date: 3/31/2020
End Date: 9/1/2021
Status: Active
2020 Funds Expended: $250,000
Total Project Cost: $3,233,836
Total SCG Cost: $250,000
Total Cofunding: $2,983,836
Benefits:

UTD Next Generation NGV Driver Information System (2.20.F)

The objective is to develop and demonstrate a next-generation NGV driver information system which provides an accurate miles-to-empty estimate for the vehicle. This is particularly challenging in gaseous-fueled vehicles because the gas experiences wide ranges of temperature fluctuation as the pressure changes during fueling and engine operation. UTD's cofunding will leverage the objectives of a separate prime contract award to GTI by DOE that provides $1,000,000 in federal funds plus $1,000,000 of in-kind partner support. GTI will model the thermodynamics of the vehicle tank(s), the key technical hurdle for this project. Our partner at Argonne National Lab will adapt a previously developed NGV fleet navigation application to utilize the miles-to-empty data to optimize fleet efficiency. At the conclusion of the DOE project, the team will engage potential commercial partners for licensing opportunities.

Cofunders: UTD Members, DOE

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $7,700
Total Project Cost: $2,250,000
Total SCG Cost: $15,400
Total Cofunding: $2,000,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD NGV America Technical Comm Participation and Representation - Phase 5 (2.16.O.5)

NGVA is a national organization dedicated to the development of a growing and sustainable market for vehicles powered by natural gas or biomethane to benefit consumers and the environment. NGVA represents more than 230 companies, environmental groups, and government organizations interested in the promotion and use of natural gas and renewable natural gas as transportation fuels. Its members produce, distribute, and market natural gas and renewable natural gas across the country; manufacture and service natural gas vehicles, engines, and equipment; and operate fleets powered by gaseous fuels.

Cofunders: UTD Members, GTI

Start Date: 7/1/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $12,000
Total Project Cost: $90,000
Total SCG Cost: $12,000
Total Cofunding: $15,000
Benefits:

UTD NGV America Technology Committee Participation and Representation (2.16.O)

NGVA is a national organization dedicated to the development of a growing and sustainable market for vehicles powered by natural gas or biomethane to benefit consumers and the environment. NGVA represents more than 230 companies, environmental groups, and government organizations interested in the promotion and use of natural gas and renewable natural gas as transportation fuels. Its members produce, distribute, and market natural gas and renewable natural gas across the country; manufacture and service natural gas vehicles, engines, and equipment; and operate fleets powered by gaseous fuels.

Cofunders: UTD Members

Start Date: 6/27/2016
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $208,200
Total SCG Cost: $43,200
Total Cofunding: $165,000
Benefits:

UTD NGV Codes and Standards Monitoring- Phase 4 (2.16.N.4)

The objective of this project is to monitor relevant natural gas vehicle codes and standards developments such as ANSI/CSA NGV 4.1, NGV 4.3, NGV 5.1, NGV 5.2, NGV 6.1 standards, along with NFPA 52 and ICC codes.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 9/30/2020
Status: Active
2020 Funds Expended: $0
Total Project Cost: $95,000
Total SCG Cost: $10,000
Total Cofunding: $85,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD NGV Codes and Standards Monitoring- Phase 4 (2.16.N.5)

The objective of this project is to monitor relevant natural gas vehicle codes and standards developments such as ANSI/CSA NGV 4.1, NGV 4.3, NGV 5.1, NGV 5.2, NGV 6.1 standards, along with NFPA 52 and ICC codes.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $6,500
Total Project Cost: $95,000
Total SCG Cost: $10,000
Total Cofunding: $85,000
Benefits:

SUBPROGRAM: REFUELING STATIONS

Fluor 1000kg Hydrogen Production Station Feasibility Study

Fluor conducted a feasibility study to analyze potential methods of hydrogen production at rates between 800 and 1,200 kg/day, with a targeted production rate of 1,000 kg/day. The hydrogen generated will be stored and dispensed for vehicle use at an adjacent on-site fueling station that can service both light-duty vehicles and heavy-duty vehicles.

Cofunders: N/A

Start Date: 8/5/2019
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $35,145
Total Project Cost: $295,000
Total SCG Cost: $295,000
Total Cofunding: $0
Benefits:

GTI CNG Smart Station Demonstration

GTI and the UT-CEM are proposing to develop a smart CNG station to eliminate issues associated with CNG underfilling. The goal of this project is to demonstrate an advanced control algorithm in a smart vehicle and dispenser, as well as a simple and cost-effective method for conditioning gas as it is dispensed into an NGV in order to effectively manage the temperature and density changes currently preventing vehicles from getting a full fill.

Cofunders: UTD Members, NREL

Start Date: 1/31/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $107,500
Total Project Cost: $1,518,754
Total SCG Cost: $268,754
Total Cofunding: $1,250,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GTI H2 at Scale Hydrogen Refueling Demonstration

The US DOE has awarded a project to Frontier Energy titled Demonstration and Framework for H2@Scale in Texas and Beyond. The H2@Scale project has two unique research, development, and demonstration tracks to understand the potential of integrating hydrogen with multiple platforms throughout the economy. First, the proposed H2@Scale project will include the demonstration of co-located multiple hydrogen generation and multiple hydrogen use applications. In the second track, the project will also leverage the experience from this demonstration, along with research and outreach, to develop a framework for additional H2@Scale pilot opportunities in Texas.

Cofunders: DOE, Cost Share

Start Date: 11/1/2019
End Date: 10/31/2021
Status: Active
2020 Funds Expended: $363,750
Total Project Cost: $10,800,000
Total SCG Cost: $483,750
Total Cofunding: $10,316,250
Benefits:

SoCalGas Coriolis Meter Total Flow Test

This test was to assess the feasibility of the technology on the integration and data transmittal to a company MCS system. SoCalGas is receiving environmental credits under California's LCFS program for CNG dispensed to NGVs as a transportation fuel. Non-transportation usage that feeds from the system needs to be excluded from the main NGV meter. Currently some of SoCalGas's CNG stations are being used for other purposes. Two main operations that utilize CNG in their operation are Pipeline Safety Enhancement Plan and Customer Services. A Coriolis Transmitter with display was installed on the system to track CNG consumption used for non-transportation purposes. Manual readings were taken monthly by field staff and submitted via email.

Cofunders: N/A

Start Date: 8/19/2019
End Date: 11/30/2020
Status: Completed
2020 Funds Expended: $65
Total Project Cost: $30,000
Total SCG Cost: $30,000
Total Cofunding: $0
Benefits:

UTD CNG Dispenser Tank Communication (2.19.G)

The objective of this project is to design, build, and demonstrate a prototype smart CNG station that includes a smart CNG dispenser and a smart NGV. The team will develop precommercial prototype hardware and protocols that enable the vehicle and station to communicate information about the vehicle's fuel system, including real-time pressure and temperature, tank volume, and age of the CNG fuel system. This information will enable safer, fuller fills of the NGVs, while also enabling fleets to more accurately track their vehicles' fuel consumption.

Cofunders: UTD Members, CSA, DOE

Start Date: 9/1/2019
End Date: 9/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,785,000
Total SCG Cost: $40,714
Total Cofunding: $2,744,286
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD CNG Station Methane Measurment Investigation (2.17.H)

While NGVs have demonstrated significant reductions in many criteria pollutants and ozone-forming emissions, one component that was not included in most past regulations is methane. Although methane is not present in gasoline or diesel fuel, it is the predominant compound in natural gas and therefore even relatively small amounts of methane leakage at a CNG fueling station can cause concern. New US EPA GHG standards are expected to regulate total GHG emissions, including methane emissions. The objectives of this project were to quantify the leaks and losses of natural gas in the CNG fueling process within a CNG fueling station, evaluate advanced compression technologies, and provide guidance on tracking methods to monitor station leakage performance to maximize operational efficiency and minimize leaks and losses.

Cofunders: UTD Members

Start Date: 6/1/2017
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $100,000
Total SCG Cost: $2,500
Total Cofunding: $0
Benefits:

UTD CNG Station Methane Release and Measurement Investigations - Phase 2 (2.17.H.2)

The project is to identify and quantify sources of emissions from CNG fueling stations to support efforts to prioritize planning and strategies to mitigate these losses. In addition to the economic importance of minimizing losses from CNG fueling stations, the US EPA and certain state air protection districts are beginning to propose or adopt regulatory limits on methane releases. Using the results from Phase 1, along with findings from a project funded by the CEC, this Phase-2 project will evaluate advanced compression technologies with the potential for reductions in current losses. The CEC project includes emissions testing at ~30 CNG fueling stations and improves the statistical ignificance of the baseline measurement results. The Phase-2 project will also evaluate or develop new or improved methods for real-time or periodic monitoring of station leakage from compression technology and fueling in a cost-effective manner.

Cofunders: UTD Members

Start Date: 6/1/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $10,300
Total Project Cost: $100,000
Total SCG Cost: $10,300
Total Cofunding: $0
Benefits:

UTD Cost Effective CNG Precooling Technologies (2.18.I)

In this project, a gas expander was designed to remove energy from high-pressure CNG or hydrogen as it drops in pressure from the fueling station to the vehicle. Removing energy from the gas causes the CNG or hydrogen to drop in temperature, offsetting the effects of heat of compression in the vehicle's storage cylinders. This precooling enables vehicles to achieve fuller fills, better utilizing the expensive storage cylinders onboard the vehicle. This enables either increased range or a smaller, less expensive fuel storage system. In addition, the gas expander can generate power from the energy being removed from the gas. This can be used to offset the power consumed by the station compressor, lowering the operating cost of the station.

Cofunders: UTD Members, DOE

Start Date: 7/1/2018
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $2,650,000
Total SCG Cost: $45,000
Total Cofunding: $2,500,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Cost Effective CNG Precooling Technologies - Phase 2: Free Piston Gas Expander (2.18.I.2)

This effort will assess various precooling technology options, including vapor compression chiller (with and without thermal storage); using the CNG compressor to serve as a refrigerant loop to leverage existing hardware for cooling; turbo expander technology; and other technologies. The project team will design, build, and demonstrate a novel expander to precool CNG in order to achieve full fills of CNG storage tanks on NGVs and thus increase effective storage capacity by 20-25%. This will reduce the cost and improve the range of NGVs, leading to increased NGV adoption and greater customer savings and satisfaction. The overall goal is to achieve full CNG tank fills at ambient temperatures up to 100°F and a capital cost of $50 per SCFM.

Cofunders: UTD Members

Start Date: 9/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $10,000
Total Project Cost: $2,650,000
Total SCG Cost: $20,000
Total Cofunding: $2,500,000
Benefits:

UTD Design of Mitigation Solutions for CNG Contamination - Phase 3 (2.14.K.3)

This project successfully designed, built, and operated a test stand for evaluating activated carbon adsorbent filters. The primary findings of this study were that an activated carbon filter sized for liquid-phase adsorption is preferred due to the high density of CNG. The maximum velocity through a filter of this adsorbent should be no more than 30 ft/min and the volume of the filter should be sized to capture no more than 5.6 pounds of oil per cubic foot of adsorbent. Adsorbent filtration carries substantial maintenance costs, roughly $0.05/GGE to flow through the filters. This economic impact should be considered in deciding if this filtration is necessary for an application.

Cofunders: UTD Members

Start Date: 7/3/2017
End Date: 6/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $75,000
Total SCG Cost: $4,500
Total Cofunding: $0
Benefits:

UTD Distributed Generation for EV Charging - Phase 2 (2.19.H.2)

The objective is to identify key technical issues or advancements necessary for gas-powered distributed generation technology solutions to be successful in this large, emerging market, and focus in more detail on the technical barriers and opportunities for DG charging solutions in these applications. This project will build upon Phase-1 results to determine the business case requirements and best applications to utilize natural gas and propane-powered DG solutions to expand EV charging infrastructure. Phase 2 will also address other potential barriers identified in Phase 1, such as uncertain cost of deployment or uncertain cost per mile. Phase 2 will also identify a specific site for an initial demonstration. Utilizing a WTW environmental model, the team will assess state-of-the-art power generation options (i.e. advanced genset, turbine, fuel cell, microgrids), relative to using the grid or smart-grid options for EV charging site electrical supply.

Cofunders: UTD Members, PERC

Start Date: 7/1/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $9,000
Total Project Cost: $50,000
Total SCG Cost: $9,000
Total Cofunding: $41,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Distributed Generation for EV Charging (2.19.H)

The objective of this project was to determine if the unique technical requirements, environmental sensitivity, and significant financial support to expand widespread EV charging infrastructure provide an opportunity for natural gas and propane-powered DG solutions. The project team assessed if state-of-the-art solutions (i.e. advanced genset, turbine, fuel cell, CHP) could be cleaner, more flexible, and more feasible in certain locations, or provide other benefits than the grid or other options for EV charging site infrastructure. The project will also identify any key technical issues or advancements for natural gas-related technology solutions necessary for success in this large emerging market.

Cofunders: UTD Members, PERC

Start Date: 7/1/2019
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $50,000
Total SCG Cost: $8,800
Total Cofunding: $41,200
Benefits:

UTD Free Piston Linear Motor CNG Compressor - Phase 2 (2.14.F.2)

GTI fabricated four stages of gas compression to demonstrate a ~50 SCFM CNG compressor at >4,500 psig using commercial linear motors with the FPLM design developed in GTI's work with the University of Texas Center for ElectroMechanics. Large fleets and public access fueling stations can more easily be cost-justified than lower-capacity applications primarily due to high capital and operating costs. For increased NGV penetration, the industry is in need of a CNG compressor with lower maintenance, increased reliability, improved gas quality, and a capital cost that can show attractive economics in the 50-150 SCFM range (approximately 24-72 GGE per hour). It will take technology advancement, not simply economies of scale savings from increased unit quantities, to show an attractive ROI in comparison to home fueling.

Cofunders: UTD Members

Start Date: 7/1/2017
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $300,000
Total SCG Cost: $52,500
Total Cofunding: $247,500
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

CLEAN GENERATION

SUBPROGRAM: DISTRIBUTED GENERATION

EPRI ORC Waste Heat Recovery Demonstration

The objective of this project is to demonstrate the technical and economic feasibility of a cost-effective organic rankine cycle (ORC) package to recover very low-grade waste heat from natural gas industrial processes. The project team will install a commercially available ORC system at a SoCalGas customer site for monitoring and verification. When complete, the project will identify key factors dictating project economics, lifecycle costs, and opportunities for improvement and optimization that could lead to further market adoption and better economics.

Cofunders: CEC

Start Date: 12/1/2015
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,146,739
Total SCG Cost: $150,000
Total Cofunding: $996,739
Benefits:

GTI Marathon Engine Systems mCHP Performance and Emissions Testing

Together with the Marathon Engine Systems (MES) team, GTI tested a commercially ready, UL and CSA certified ecopower unit to characterize and validate system performance and emissions levels. Tests were conducted under controlled conditions to evaluate the system heat and power capacities, and efficiencies at various part-load conditions, return water temperatures and natural gas supply pressures. Emissions data were collected at 50%, 75%, and 100% part-load power capacities to compare with CARB and EPA emission regulations. Emissions testing results satisfied CARB-DG requirements for CO, NOx, and VOCs.

Cofunders: N/A

Start Date: 4/1/2020
End Date: 12/9/2020
Status: Completed
2020 Funds Expended: $50,000
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

GTI Marathon/EC Power mCHP Testing and Demonstration

The objective of this project is to test and demonstrate two micro combined heat and power (mCHP) systems, a 4.5 kW Marathon and an 25 kW EC Power, with the intent of applying for CARB DG certification. Operating the systems in a lab environment will allow GTI to confirm the performance and emissions of the two systems prior to deploying in a field demonstration. Once the systems are confirmed to meet emissions requirements, they will be installed at customer facilities within SoCalGas territory and monitored for real-world performance.

Cofunders: CEC, Marathon Engine Systems, AO Smith Corporation

Start Date: 7/1/2018
End Date: 10/31/2021
Status: Active
2020 Funds Expended: $50,000
Total Project Cost: $1,667,006
Total SCG Cost: $100,000
Total Cofunding: $1,567,006
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GTI Upstart Residential SOFC Lab Evaluation

The objective of this project is to evaluate the performance of the Upgen 10 solid oxide fuel cell (SOFC) system operating on natural gas. Unlike other SOFC systems, Upstart claims its system is designed to achieve fast start/stop times, while maintaining cyclic durability. GTI will assess the technical performance of the unit and identify any performance issues. The evaluation will include assessing current/voltage/power characteristics, efficiencies, system endurance, stack degradation, load following capabilities, rapid start-up and shut-down cyclability, and emissions.

Cofunders: N/A

Start Date: 8/17/2020
End Date: 8/31/2021
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $190,000
Total SCG Cost: $190,000
Total Cofunding: $0
Benefits:

LBNL Metal-Supported SOFC Development

The objective of this project is to demonstrate LBNL's metal-supported solid oxide fuel cell (MS-SOFC) technology operating with Natural Gas, and determine future technical improvements that are required for commercialization. LBNL has developed MS-SOFC cells with unique symmetric architecture and infiltrated catalysts, and has general expertise on the development and testing of MS-SOFCs. LBNL will demonstrate the feasibility of using MS-SOFCs with Natural Gas for applications that require rapid start/stop cycles by: 1) determining performance and durability of existing MS-SOFC technology with NG; 2) screening electrochemical and reforming catalyst compositions for improved performance; and 3) demonstrating rapid thermal cycles with NG fuel.

Cofunders: N/A

Start Date: 11/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $375,000
Total Project Cost: $375,000
Total SCG Cost: $375,000
Total Cofunding: $0
Benefits:

Noble Thermodynamic Systems Ultra-Efficient CHP using a Novel Argon Power Cycle Development

The objective of this project is to demonstrate the ability of the novel Argon Power Cycle (APC) to provide an 18% increase in efficiency, while eliminating emissions, in an internal combustion engine. The Argon Power Cycle was developed by researchers at UC Berkeley. It utilizes a closed loop internal combustion engine with Argon as the working fluid (instead of air), in conjunction with a membrane gas separation unit. The inherent nature of the system completely eliminates air pollutants and GHG emissions. The project will be completed in two phases: 1) high-fidelity modeling and sub-component development; and 2) full system integration and operation.

Cofunders: DOE, Private Investors

Start Date: 4/1/2020
End Date: 3/31/2023
Status: Active
2020 Funds Expended: $250,000
Total Project Cost: $5,279,034
Total SCG Cost: $500,000
Total Cofunding: $4,779,034
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

QSI Nano-Power Generation System Proof-of-Concept

The objective of this project is to conduct a proof-of-concept test of the QuSwami, Inc (QSI) patented Nano-Power Generation System, running on natural gas. QSI's system utilizes Electricity Emitting Diodes (EEDs), which directly and efficiently generates power from an energy source via gas-phase catalytic reactions on an EED's nano-surface to generate hot electrons. QSI's foundational research shows that direct conversion of chemical energy from gas-phase catalytic reactions has the potential of achieving higher fuel efficiency than most existing electricty generation technologies. The project will include re-designing the reactors to withstand higher temperatures required for the testing, measuring exhaust composition, and measuring output voltage from the EEDs.

Cofunders: N/A

Start Date: 9/9/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

Scaled Power 40kw Turbogenerator Low Emissions Burner Development and Testing

The objective of this project is to further the development of Scaled Power's 40kW Turbogenerator and perform emissions testing. The Turbogenerator will be redesigned and fabricated based on lessons learned from a prior project phase. The system will also be integrated with a low-emissions combustor, which utilizes Low Swirl Burner (LSB) technology developed by LBNL. Once the system is updated and integrated with the new burner, emissions testing will be performed to determine if the system can meet CARB-DG requirements. Scaled Power's Turbogenerator utilizes off-the-shelf automotive components combined with a gearless electric auxiliary power unit to simplify the system and minimize costs.

Cofunders: US Air Force

Start Date: 7/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $180,000
Total Project Cost: $464,000
Total SCG Cost: $232,000
Total Cofunding: $232,000
Benefits:

UCI Effect of Hydrogen Addition into Natural Gas on SCR of NOx Lab Testing

The objective of this project is to investigate the impact hydrogen-blended natural gas has on the performance of selective catalytic reduction (SCR) units for deNOx. SCR of NOx is used in several applications such as gas-fired utility boilers, process heaters, gas turbines and stationary engines. Flue gas composition is known to affect catalyst performance. Since hydrogen is a carbon-free fuel, the combustion products are different than that of a carbon-containing fuel. Introducing a flue gas with a different composition into the SCR unit would affect the chemistry that is taking place on the catalyst, hence the performance of the catalyst. This might cause a change in the resulting NOx emissions downstream of the SCR unit, which would be released from the stack.

Cofunders: N/A

Start Date: 10/5/2020
End Date: 4/30/2022
Status: Active
2020 Funds Expended: $90,000
Total Project Cost: $195,000
Total SCG Cost: $195,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UCI Fuel Flexible Microturbine Generator Development

The objective of this project is to demonstrate low-emissions operation of a hydrogen-tolerant microturbine-based CHP system. UCI will modify a Capstone C-60 microturbine to accept hydrogen-blended fuel. This project builds upon previous work performed by UCI and Capstone with the support of the CEC and DOE. UCI will work with Capstone to modify the injectors in order to achieve low emissions at varying levels of hydrogen blended fuel, up to 100%.

Cofunders: N/A

Start Date: 5/1/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $100,000
Total SCG Cost: $100,000
Total Cofunding: $0
Benefits:

UCI Fuel Flexible Rotary Engine MicroCHP Development

The objective of this project is to demonstrate the robustness of operation and the extent of low-emission performance of a rotary-engine-based microCHP system operating on varying levels of hydrogen blended fuel, up to 100%. This project leverages the CEC-supported development of a rotary engine operating on natural gas, integrated with a generator and heat recovery systems. The engine will be operated and monitored in the lab, with the goal of potentially installing the unit at the campus recreation center in a future phase.

Cofunders: N/A

Start Date: 7/1/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $100,000
Total SCG Cost: $100,000
Total Cofunding: $0
Benefits:

UCI Low Cost Sensors for Smart Burners Research

The objective of this project is to evaluate the robustness and accuracy of low-cost emissions and fuel composition sensors that can be integrated into control systems of high-performance natural gas equipment (microturbines, smart appliances, smart heaters, etc.). Low-cost real-time sensors have the ability to maintain the high performance characteristics of equipment while adapting to increasingly renewable fuels.

Cofunders: N/A

Start Date: 8/1/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $21,500
Total Project Cost: $136,500
Total SCG Cost: $136,500
Total Cofunding: $0
Benefits:

UTD Capstone C200S Microturbine Lab Evaluation (2.18.E)

The objective of this project is to evaluate and characterize the performance of the newly launched 200 kW Capstone C200S Signature Series microturbine. According to Capstone, the unit incorporates numerous system and design upgrades including integrated heat recovery, two-stage air filtration, an acoustically enhanced enclosure, and reconfiguration for ease of installation and integration. The unit has a stated electrical efficiency of 33% (LHV). In a combined heat and power format, system efficiency may reach up to 90%.

Cofunders: UTD Members, Power Flame

Start Date: 7/1/2018
End Date: 10/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $185,000
Total SCG Cost: $19,800
Total Cofunding: $165,200
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Cost Optimization of 3D Printing of Advanced Burners for CHP and Distributed Generation (2.18.A)

The objective of this project was to provide to manufacturers a low-first-cost, high-efficiency, low-emissions 3D-printed advanced nozzle burner with improved performance and economy by optimizing the design, material selection, processing, and other factors. GTI successfully designed and developed a 3D printed scale-up burner capable of firing up to 3 MMBtu/h for air heating applications. GTI designed the air heating hardware, including the burner assembly and the cross-flow process air ducting, for improved mixing and increased efficiency. GTI was able to lower the cost significantly from traditional manufacturing and reduce the cost for 3D manufacturing by 30% by design and post-processing step reduction.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 12/11/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $140,000
Total SCG Cost: $20,000
Total Cofunding: $120,000
Benefits:

UTD CYSORE 24kW mCHP and Chiller System – Lab Test (2.19.F)

The objective of this project is to evaluate the CYSORE 24kW micro-Chiller in GTI's laboratory, and support development of the technology by validating performance and other competitive analysis benchmarking. Evaluation metrics will include power, refrigeration, hot water production, efficiencies, and emissions at various ambient and transient loading conditions.

Cofunders: UTD Members, CYSORE

Start Date: 7/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $7,714
Total Project Cost: $205,000
Total SCG Cost: $16,714
Total Cofunding: $188,286
Benefits:

UTD Emerging Rescom Fuel Cells – Laboratory Evaluations (1.20.F)

The objective of this project is to evaluate the merits of at least six residential/small-commercial scale fuel cell systems less than 50kW and prioritize them in terms of North American market fit and readiness. Based on the prioritization, GTI will select one system for further evaluation in the laboratory in order to characterize its power/thermal capacities, efficiencies, and qualities as well as modulation and cycling capabilities. Laboratory research will focus on achieving high mCHP electrical efficiencies and near zero emission levels.

Cofunders: UTD Members, PERC

Start Date: 7/1/2020
End Date: 10/31/2021
Status: Active
2020 Funds Expended: $16,500
Total Project Cost: $190,000
Total SCG Cost: $27,798
Total Cofunding: $162,211
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD EnviroPower 6kW SmartWatt and BRASH 3kW STRAUM mCHP Boilers Lab Test (2.19.E)

The objective of this project is to evaluate the 6kW EnviroPower and 3kW BRASH STRAUM Micro-CHP (mCHP) self-powered hydronic HVAC boiler systems in the laboratory, and support their development by validating performance and other competitive analysis benchmarking. Evaluation metrics will include power, thermal production, efficiencies, and emissions.

Cofunders: UTD Members, BRASH, EnviroPower

Start Date: 7/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $10,588
Total Project Cost: $190,000
Total SCG Cost: $22,588
Total Cofunding: $167,412
Benefits:

UTD Long Term Performance and Reliability of CHP and DG Systems Study (2.17.E)

The objective of this project is to analyze the longterm reliability and availability performance of existing natural gas-fueled CHP or DG technologies, based on available data from select sources. The ultimate goal is to identify typical CHP/DG failure modes and potential research and development opportunities to improve the performance of CHP/DG systems.

Cofunders: UTD Members

Start Date: 7/1/2017
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $13,333
Total Cofunding: $136,667
Benefits:

UTD Micro-CHP Characterization and Demonstration (2.18.H)

The objectives of this project were to 1) characterize key mCHP technologies and determine regional technical and economic viabilities of those technologies in residential and commercial applications; and 2) increase market adoption of mCHP by providing an influential California market with qualified, well-established, and cost-effective systems. A wide range of technologies were evaluated, including engine and fuel cell based systems. The residential model included a fully integrated system, including power, space heating, water heating, and cooling. Analysis showed greater than 20% energy cost savings in most cases. The commercial system analysis showed that payback period was more variable across the different technologies, and more dependent on tax incentives and resilience value.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 4/27/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $130,000
Total SCG Cost: $5,474
Total Cofunding: $124,526
Benefits:

UTD M-Trigen Micro-CHP System Demonstration – Phase 2 (2.16.H.2)

The objective of this project is to evaluate and support M-Trigen in the development of cost-effective self-powered and uninterruptible space heating and cooling, and water heating in the laboratory. GTI will work with M-Trigen to develop an emissions control solution and evaluate the technical performance of two M-Trigen systems.

Cofunders: UTD Members, M-Trigen, New Jersey Natural Gas

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $10,737
Total Project Cost: $230,000
Total SCG Cost: $22,737
Total Cofunding: $207,263
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD On-Site Electrical Generation – Phase 2 (2.15.A.2)

The objective of this project is to design, build and demonstrate a compact low-emission Thermal PhotoVoltaic concept for a CHP system that can provide high power generation efficiencies and allow wide variations in the amount of power and thermal energy (hot water) generated.

Cofunders: UTD Members, MicroLink Devices

Start Date: 7/1/2018
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $200,000
Total SCG Cost: $22,200
Total Cofunding: $177,800
Benefits:

UTD Reliability of Natural Gas for Standby Generation – EPSS Phase 3 (2.12.F.6)

This project addressed current barriers for natural gas on-site power generation by creating and disseminating technical content on the advantages of natural gas standby generation and supporting claims that the utility natural gas supply can be as, or more reliable, than on-site diesel fuel storage. GTI worked with industry partners to develop and update tools, performance data, and case studies to help customers make well-informed decisions.

Cofunders: UTD Members, Generac

Start Date: 8/1/2018
End Date: 11/11/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $90,000
Total SCG Cost: $1,000
Total Cofunding: $89,000
Benefits:

UTD Ultra-High Efficiency Natural Gas Fired Combustion Systems for mCHP (2.18.F)

The objective of this project was to develop a high efficiency, ultra-low-emisisons combuster system to be used in a Stirling engine-based mCHP system. The mCHP unit was developed as part of the DOE ARPA-E GENSETS effort. Testing was performed to determine the system's ability to meet CARB emissions requirements. Initial tests were unable to meet the specified emissions limits. System improvement opportunites and alternative applications were identified.

Cofunders: UTD Members, ARPA-E, OEMs

Start Date: 7/1/2018
End Date: 6/11/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $975,000
Total SCG Cost: $25,701
Total Cofunding: $949,299
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: INTEGRATION & CONTROLS

Blue Frontier Fuel Cell Powered HVAC Development

The objective of this project is to investigate the integration of a fuel cell with Blue Frontier's Enhanced Liquid Desiccant Energy Storage Air Conditioning. This technology, originally developed by NREL, recovers and stores the waste heat from a fuel cell in order to provide on-demand cooling. In Phase 1, the team established the value proposition for the product, developed baseline models, and explored building energy savings at different locations throughout California. In Phase 2, Blue Frontier will design, procure, configure, build and test the equipment at NREL, then issue a final report.

Cofunders: N/A

Start Date: 11/1/2019
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $175,000
Total Project Cost: $540,000
Total SCG Cost: $540,000
Total Cofunding: $0
Benefits:

Kevala Microgrid Site Identification Study

The objective of this project was to evaluate Kevala's Assessor Platform, as well as identify sites for potential natural gas- and/or hydrogen-supported microgrid development. Kevala's Assessor Platform is an artificial intelligence enabled data analytics tool used for distributed energy resources planning. The project was conducted in three phases: 1) site criteria development; 2) site scoring; and 3) final report. SoCalGas worked with Kevala to identify key criteria, including CPUC fire map tiers, types of critical facilities, and minimum site loads. Based on the identified criteria, assigned weights, and input from the SoCalGas RD&D and DER Strategy teams, Kevala provided a report for the top eight potential sites. The final report included geographic parcel information, as well as estimated daily and annual electric load ranges.

Cofunders: N/A

Start Date: 3/2/2020
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $68,000
Total Project Cost: $68,000
Total SCG Cost: $68,000
Total Cofunding: $0
Benefits:

UCI Fuel Cells in Data Centers Study

The objective of this project is to advance the understanding of how gas-fueled solid oxide fuel cells (SOFC) and proton exchange membrane fuel cells (PEMFC) may be able to provide power to data centers and other critical infrastructure with sufficient reliability and resiliency. It will also evaluate the environmental and economic benefits of fuel cell system use in comparison to alternatives. The project will leverage funding from Microsoft to demonstrate fuel cells directly powering server racks, while utilizing waste heat for data center cooling and dehumidification.

Cofunders: Microsoft

Start Date: 10/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $57,000
Total Project Cost: $540,000
Total SCG Cost: $190,000
Total Cofunding: $350,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UCI Integrated SOFC, Solar, and Storage System in ZNE Residential Nanogrid Design

The objective of this project is to design and analyze a residential nanogrid that integrates an SOFC, CHP, PV solar, and energy storage. The goal will be to dynamically operate the system in order to meet typical residential heating and power demands, while simultaneously achieving zero net energy. The economic, environmental, and resiliency benefits of the system, in comparison with alternatives, will also be analyzed in this project.

Cofunders: N/A

Start Date: 10/1/2019
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $65,000
Total Project Cost: $325,000
Total SCG Cost: $325,000
Total Cofunding: $0
Benefits:

UTD DG/CHP for Electric Demand Response (2.19.C)

The objective of this project is to develop a technical, economic, and regulatory assessment of opportunities for peak electric demand response that can be achieved from DG and CHP installations. GTI will provide guidelines for regional DR programs; identify target applications, technologies or regions with the most cost-effective DSM/DR opportunities; and identify applicable code requirements and regulatory barriers.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $100,000
Total SCG Cost: $32,000
Total Cofunding: $68,000
Benefits:

UTD Integrated CHP System for Multi-Family Buildings (1.20.J)

The goal of this project is to perform a laboratory evaluation of the EC Power/Lochinvar XGRi25 mCHP unit in a multi-family scenario when coupled with best-in-class EHPs responding to individual homes' heating and cooling demand. With integrated smart thermal storage and management capabilities, the XGRi25 along with advanced EHPs will operate as an advanced gas-fired integrated system with annual gas efficiencies greater than 100% for heating, cooling, and hot water loads.

Cofunders: UTD Members

Start Date: 6/1/2020
End Date: 1/31/2022
Status: Active
2020 Funds Expended: $15,000
Total Project Cost: $250,000
Total SCG Cost: $30,000
Total Cofunding: $220,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Integrating Micro-CHP and PV in Advanced Gas/Renewable Homes (2.18.G)

The objective of this project was to expand the mCHP and PV capabilities in the VTH in GTI's laboratory. By expanding the VTH, GTI will be able to leverage these assets in the future to systematicaly test and develop new technolgies for integrated systems with dual-fuel, thermal storage, power generation, off-grid capabilities for space heating and cooling and hot water. By having a fully integrated system, technologies will be able to be better optimized for performance in simulated real-world conditions to achieve reduced emissions while improving system functionality.

Cofunders: UTD Members, Aisin

Start Date: 6/1/2018
End Date: 4/27/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $190,000
Total SCG Cost: $31,500
Total Cofunding: $158,500

Benefits:

Reliability

Safety

Operational Efficiency

Improved Affordability

Environmental: Reduced GHG Emissions

Environmental: Improved Air Quality

CUSTOMER END-USE APPLICATIONS

SUBPROGRAM: ADVANCED INNOVATION

GTI Improving Efficiency of Wall Furnaces in CA Homes Demonstration

GTI is seeking to accelerate the availability and adoption of higher efficiency retrofit options for atmospherically vented wall furnaces prevalent in California's affordable multifamily housing. GTI anticipates that the retrofit packages will result in 10-20% annual savings with a 10-year payback over existing replacement technologies. To accelerate adoption, the project team will conduct market outreach and technology transfer to property owners, installers, manufacturers, and utilities.

Cofunders: CEC

Start Date: 7/31/2019
End Date: 8/15/2022
Status: Active
2020 Funds Expended: $27,500
Total Project Cost: $1,110,000
Total SCG Cost: $110,000
Total Cofunding: $1,000,000
Benefits:

Resource Innovations NA Gas Heat Pump Collaborative

A number of North American utilities, including SoCalGas, are interested in participating in a collaboration to design and implement activities that will accelerate the commercialization and market acceptance of GHP in North America. The overall goal of this collaboration is to join forces to secure a dramatically enhanced market share of GHP technologies and energy-efficient gas technologies by working together across a number of North American LDCs.

Cofunders: N/A

Start Date: 1/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $78,580
Total Project Cost: $104,280
Total SCG Cost: $104,280
Total Cofunding: $0
Benefits:

UTD Carbon Management Information System (GTI 21917/22060)

The objectives of this project are to provide participating CMIC members a web-based tool to analyze source energy consumption and environmental impacts (GHGs) related to natural gas used in commercial/institutional and industrial applications. Another objective of this project is to provide participating CMIC members and their clients with a user friendly Internet server-based tool allowing realistic analysis of source energy consumption and environmental impacts (GHGs) related to energy used by selected commercial/institutional buildings and industrial applications. The program uses the latest eGRID 2007 v1.1 database to calculate electric power plant efficiency, fuel mix, and emissions data (carbon dioxide, SO_2, NOx, N2O, methane, and Hg) associated with site annual energy consumption. Source energy consumption and emissions from extraction, processing, transportation, and distribution of fuels used to generate electricity and those consumed on site are also calculated.

Cofunders: UTD Members

Start Date: 1/21/2016
End Date: 4/1/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,851,400
Total SCG Cost: $280,000
Total Cofunding: $2,571,400
Benefits:

Reliability

Safety

Operational Efficiency

Improved Affordability

Environmental: Reduced GHG Emissions

Environmental: Improved Air Quality

UTD Gas Fired High Efficiency Liquid Desiccant Air Conditioning and Humidity Control – Phase 2 (1.15.E.2)

The goal of this project is to develop a gas-fired liquid desiccant dedicated outdoor air system that addresses many of the critical issues now facing the HVAC industry. In this project, a research team is collaborating with a manufacturer to compare the current state-of-the-art liquid desiccant dedicated outdoor air system technology to other advanced systems and then to design and experimentally evaluate a breadboard liquid desiccant dedicated outdoor air system test rig rated at approximately 100 CFM capacity using a novel non-corrosive, non-toxic desiccant.

Cofunders: UTD Members, NYSERDA

Start Date: 6/1/2018
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $415,000
Total SCG Cost: $4,000
Total Cofunding: $411,000
Benefits:

UTD Investigating Multifamily Infrastructure Challenges – Phase 4 (1.14.J.4)

The objectives of this project are to evaluate the current position of the natural gas industry in multifamily new construction and develop recommendations for improvement. The goals are to develop concrete market transformation implementation tools and action plans to properly connect with new development decision-makers to keep natural gas viable in new multifamily construction. The project will conduct white-labeled case studies and economic assessments, review strategy and emerging gas technologies to ease gas infrastructure challenges in multifamily buildings, and develop continuing education credit curriculum tailored to design professionals that can be delivered as lunch-and-learn sessions by natural gas utility representatives.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2019 Funds Expended: $0
Total Project Cost: $127,000
Total SCG Cost: $1,984
Total Cofunding: $125,016
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SUBPROGRAM: COMMERCIAL APPLICATIONS

GTI Gas Heat Pump Water Heating and Space Cooling in Restaurants Demonstration

In this project, GTI is conducting a field demonstration of an advanced precommercial GHP for commercial hot water and space cooling as applied to two restaurants. With data generated, the project team will 1) develop tools to extrapolate results to other restaurant-types, other light-commercial facilities, and California climate zones, and 2) quantify the barriers to adoption of this advanced technology.

Cofunders: CEC

Start Date: 4/17/2017
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,090,294
Total SCG Cost: $226,000
Total Cofunding: $864,294
Benefits:

GTI Model-Based Control Hospital Decarbonization Demonstration

The objective of this project is to demonstrate an integrated solution for reducing heating and hot water loads in order to decarbonize large commercial buildings. In this project, GTI will design, model, implement, and demonstrate novel integrated HVAC technologies and a model-based control system to significantly reduce energy use and GHG emissions and monitor and report real energy savings and GHG reductions from the installation of advanced technologies at the Baldwin Park Medical Center. The project team anticipates demonstrating an overall 30% reduction in natural gas usage and a simple payback of seven years, advancing the technologies integrated with model-based optimal control from TRL7 to TRL9 by the end of the project, and showcasing the retrofit measures and energy savings through outreach to encourage similar implementations of energy saving measures throughout the state.

Cofunders: CEC

Start Date: 12/1/2020
End Date: 3/31/2024
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,585,954
Total SCG Cost: $161,250
Total Cofunding: $1,424,704
Benefits:

GTI Technical Assistance and Assessments

In this project, GTI provides technical support to SoCalGas on a broad range of topics connected to end use applications of natural gas and renewable energy. GTI is developing quick-turnaround technical assistance and assessments that support SoCalGas' efforts to address critical customer issues such as emissions equivalency, energy efficiency, carbon emission reduction, and cost-effectiveness. To ensure effective coordination of efforts between SoCalGas and other parties, this information will be complemented by tracking SoCalGas' current and future RD&D activities.

Cofunders: N/A

Start Date: 4/2/2017
End Date: 4/2/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $250,000
Total SCG Cost: $250,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

ICF Commercial Building Methane Leak Study

Co-funded through CEC PIR-15-017, researchers from ICF and GTI developed methods for field testing and estimating methane emissions from commercial buildings in California. Analysis captured post-meter methane emissions data from natural gas appliances and pipe system components from a small sample of buildings, then estimated total annual building-level and statewide emissions. The team estimated total fugitive methane emissions from commercial buildings across California to be 540 - 620 million cubic feet per year as measured or 311 - 392 million cubic feet per year for the alternative estimate designed to reduce the impact of outliers. Because of factors such as a limited number of buildings and appliances analyzed and outliers in the sample, the uncertainty associated with this analysis is very high, with a range of emissions spanning approximately 78.6 million to 1.1 billion cubic feet per year. The study found that most gas piping and equipment in the sample of commercial buildings operated with low to no fugitive methane emissions, with a small percentage of sources accounting for most emissions. The final report was published by the CEC in July of 2020.

Cofunders: CEC

Start Date: 6/30/2018
End Date: 7/1/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $809,683
Total SCG Cost: $210,000
Total Cofunding: $599,683
Benefits:

Low Emission Efficient Burner for Ovens and Dryers (2.20.A)

The objective of this project is to apply the novel burner technology previously developed in UTD 2.15.D with other product design improvements into a 3 MMBtu/hr burner assembly system to heat process air. The project seeks to validate the performance of the burner assembly first in GTI's laboratory and then at a host site (Preheat, Inc.). These efforts will help advance the commercial introduction of a more energy-efficient, low-emission burner from an OEM that will also bring increased competition into this market segment, thereby reducing costs for consumers.

Cofunders: UTD Members, Preheat Inc.

Start Date: 6/1/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $200,000
Total SCG Cost: $23,800
Total Cofunding: $176,200
Benefits:

Membrane Based Ionic Liquid Absorption Heat Pump for Commercial HVAC (1.20.I)

The objective of this project is to develop an innovative thermally-driven cooling technology for commercial HVAC and demonstrate it in a prototype ultra high-efficiency DOAS RTU, in a three-year project led by the University of Florida where UTD's funding will be leveraged by $1.6M of US DOE prime funding. The core technology under development is a novel, scalable absorption system for dehumidification using a highly efficient open double-effect liquid desiccant cycle enabled by the use of non-crystallizing ionic liquids. This absorption system is centered on a compact membrane-based heat and mass exchanger with no desiccant entrainment. The compact size facilitates easy retrofitting into existing building infrastructure. Regeneration of the system is driven by efficient heating (natural gas, propane, waste heat, solar, etc.). Modine Manufacturing, a commercial HVAC market leader, will provide industry support.

Cofunders: UTD Members, PERC, DOE

Start Date: 8/1/2020
End Date: 8/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,800,000
Total SCG Cost: $24,033
Total Cofunding: $1,775,967
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

SMTI Heat Pump Commercialization

The purpose of this project is to support the commercialization of Stone Mountain Technologies, Inc.'s novel gas absorption heat pump technology. This technology significantly increases the efficiency of gas-fired space and water heating, achieving a COP of 1.3.

Cofunders: N/A

Start Date: 11/4/2018
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $250,000
Total SCG Cost: $250,000
Total Cofunding: $0
Benefits:

UC Davis Aerosol Sealant Demonstration

This project will advance the development of a unique technology that uses aerosolized sealant particles to remotely seal leaks in the low-pressure natural gas distribution systems downstream of a building pressure regulator. This technology has been commercialized for duct sealing and building envelope sealing, but has only been tested to a limited extent for natural gas distribution sealing. Not only does this technology seal otherwise inaccessible leaks, but it also automatically tracks the sealing process, providing real-time feedback to the applicator, and documentation of the sealing performed.

Cofunders: N/A

Start Date: 7/1/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $110,614
Total Project Cost: $151,663
Total SCG Cost: $151,663
Total Cofunding: $0
Benefits:

UCI/E3 Long Term View of Natural Gas Use in California

This study evaluated scenarios that achieve an 80 percent reduction in California's GHG emissions by 2050 from 1990 levels, focusing on the implications of achieving these climate goals for gas customers and the gas system. Achieving these goals is not guaranteed and will require large-scale transformations of the state's energy economy in any scenario. Even in the High Building Electrification scenario, millions of gas customers remain on the gas system through 2050. Thus, this research evaluates potential gas transition strategies that aim to maintain reasonable gas rates, as well as the financial viability of gas utilities, through the study period. "The Challenge of Retail Gas in California's Low-Carbon Future" is the final report for the CEC's future of natural gas project (PIR-16-011) conducted by E3 and the University of California, Irvine. The report was approved in April 2020 and posted to the CEC's website. The information from this project contributes to the Energy Research and Development Division's Natural Gas Research and Development Program.

Cofunders: CEC, UCI

Start Date: 6/15/2017
End Date: 4/1/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $730,000
Total SCG Cost: $100,000
Total Cofunding: $630,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Advanced Nozzle Burner for Commercial Water Heaters – (1.18.C)

The objective of this project was to develop and demonstrate an advanced nozzle burner for commercial water heaters (200,000 Btu/hr. capacity) offering improved efficiency, turndown, emissions, stability, and compactness by testing the prototype in an AO Smith BTH 0199 commercial water heater. In this initial phase, the research team developed and performed preliminary testing of burner hardwares, controls, and water heater blower.

Cofunders: UTD Members, ORNL

Start Date: 7/1/2018
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $400,000
Total SCG Cost: $42,000
Total Cofunding: $358,000
Benefits:

UTD Advanced Nozzle Burner for Commercial Water Heaters – Phase 2 (1.18.C.2)

The objective of this project is to develop and demonstrate an advanced nozzle burner for commercial water heaters (200,000 Btu/hr. capacity) offering improved efficiency, turndown, emissions, stability and compactness by testing the prototype in an AO Smith BTH 0199 commercial water heater. In this second phase, the research team hopes to further develop the water heater prototype by implementing an advanced retention nozzle and burner and demonstrate stable and safe operations.

Cofunders: UTD Members, ORNL

Start Date: 6/1/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $300,000
Total SCG Cost: $24,000
Total Cofunding: $276,000
Benefits:

UTD Advanced Systems for Self-Powered Water Heating – Phase 3 (1.14.K.3)

This project will build, test and evaluate a TPTS system (surface combustor-heater, evaporator and condenser) for a high-efficiency (0.75 UEF) self-powered 40- or 50-gallon storage water heater with plastic tank, rapid startup, and long-life, with minimal stand-by heat loss and scaling.

Cofunders: UTD Members, Rheem

Start Date: 7/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $165,000
Total SCG Cost: $45,000
Total Cofunding: $120,000
Benefits:

UTD Commercial Gas Fired Heat Pump Water Heater – Phase 2 (1.16.I.2)

The objective of this project is to field-demonstrate the commercial GHPWH developed in conjunction with its partner Stone Mountain Technologies Incorporated in order to extend this technology to multifamily housing, a critical market segment for UTD members, and to also advance commercialization efforts with boiler OEM Weil McLain. Phase 2 will build upon the adaptation of a low-cost GAHP technology for commercial space heating and residential combined space/water heating to commercial water heating by tying the outdoor GAHP to an indoor indirect storage tank (with or without conventional backup heating).

Cofunders: CEC, UTD Members

Start Date: 6/1/2017
End Date: 8/31/2020
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,072,800
Total SCG Cost: $22,935
Total Cofunding: $1,049,865
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Commercial Gas Fired Heat Pump Water Heater – Phase 3 (1.16.I.3)

The objective of this project is to expand the duration and impact of the field demonstration currently underway at a multi-family residence in Evanston, Illinois of the prototype high-efficiency commercial GHPWH developed in conjunction with Stone Mountain Technologies Incorporated. This project will further optimize the boiler and GHPWH controls when operating as a hybrid system, for both the specific Evanston pilot and the general case. The project team will extrapolate the findings and optimized controls strategies to low-rise, mid-rise, and high-rise multifamily buildings in six North American climate regions using a building simulation tool, with the goal of defining the technical potential of a Boiler/GHPWH hybrid system. Upon completion, the team will publicize the simulation results, design guidelines, and other project results in an industry white paper(s) to advance discussions and actions by developers, architect/engineers, and expected commercialization partner OEM Weil McLain.

Cofunders: UTD Members, A.O. Smith

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $180,000
Total SCG Cost: $26,211
Total Cofunding: $153,789
Benefits:

UTD Comparative Assessment of Heat Pump Water Heaters in the Virtual Test Home (1.19.I)

The objective of this project was to compare gas/LPG space heating and electric heat pump space heating on a level basis by characterizing equipment part-load performance in GTI's VTH. The goals of this project were to characterize at least two EHP space heaters in the VTH, implement the characterizations in EnergyPlus building energy modeling software by updating this software with the relevant peer-reviewed data generated in this project, quantify relative annual space heating energy consumptions and GHG emissions in 15 states across five climate zones, and author a peer-reviewed technical paper for public dissemination that informs readers about the predicted energy and environmental impacts of electric, gas/LPG, and hybrid water and space heating.

Cofunders: UTD Members, PERC

Start Date: 7/1/2019
End Date: 10/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $105,000
Total SCG Cost: $5,252
Total Cofunding: $99,748
Benefits:

UTD Comparative Assessment of Heat Pump Water Heaters in the Virtual Test Home – Phase 2 (1.19.I)

The objective of this project is to evaluate globally available hybrid solutions for residential space and water heating applications in GTI's VTH. Weaknesses and strengths will be identified in the selected hybrid HVAC&DHW systems to better craft advanced heating technologies for low-operating cost and GHG emissions based on US climate zone and grid region.

Cofunders: UTD Members

Start Date: 5/19/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $130,000
Total SCG Cost: $8,432
Total Cofunding: $121,568
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Economical High-Efficiency Residential Gas Absorption Heat Pump with Integrated Cooling – Phase 2 (1.18.H.2)

The objective of this project is to finalize the design, fabrication, debugging, commissioning, and testing of a complete working "alpha" prototype unit that adds cost-effective cooling to the low-cost GAHP precommercial product developed in UTD project 1.13.F with SMTI. In this second phase, the research team hopes to perform an extensive evaluation of the alpha prototype and recommend design changes for the beta prototype.

Cofunders: UTD Members, SMTI, Natural Gas Innovation Fund

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $370,000
Total SCG Cost: $24,324
Total Cofunding: $345,676
Benefits:

UTD Elevated Gas Pressure Water Heating Appliances – Phase 2 (1.16.Q.2)

The objectives of this project were to 1) define the current market opportunities and barriers to operating elevated gas pressure appliances in residential and commercial buildings; and 2) prove the technical feasibility and benefits by operating both non-condensing and condensing gas storage and tankless water heaters at elevated gas pressures.

Cofunders: UTD Members

Start Date: 7/1/2017
End Date: 6/11/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $97,000
Total SCG Cost: $38,500
Total Cofunding: $58,500
Benefits:

UTD Enhanced Gas Space Conditioning for Greenhouse and Vertical Farming (1.19.G)

This project assessed the landscape of the CEA market as well as the opportunity for natural gas and propane technologies to provide value. Following a detailed literature review, outreach, several rounds of interviews, and research, GTI prepared a techno-economic assessment of the CEA market and identified value-adding features for gas- and propane-driven space conditioning and power systems for use in greenhouse and indoor/vertical farming operations.

Cofunders: UTD Members, PERC

Start Date: 7/1/2019
End Date: 8/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $100,000
Total SCG Cost: $13,000
Total Cofunding: $87,000
Benefits:

UTD Enhanced Gas Space Conditioning for Greenhouse and Vertical Farming – Phase 2 (1.19.G.2)

The goal of this project is to conduct a techno-economic assessment of waste, water, and air management and conservation for CEA. Analysis will include characterization of waste streams of three prototypical facilities; establishing best practices in waste management and the role of natural gas and propane; calculating the economics of natural gas and propane technologies; and identifying at least four technology development needs or opportunities.

Cofunders: UTD Members, PERC

Start Date: 7/1/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $10,000
Total Project Cost: $120,000
Total SCG Cost: $10,000
Total Cofunding: $110,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Field Evaluation of Central Condensing Tankless Water Heaters for Energy Savings (1.18.E)

The objective of this project is to perform a field demonstration of the CCTWH, an emerging technology for high-efficiency generation of SHW. This field evaluation of CCTWHs at two multifamily buildings in Minnesota will be the first third-party study to quantify the energy savings potential of CCTWH over conventional direct-fired gas storage and indirect (with dedicated boiler) SHW systems in this application. The primary goals of the project are to verify the energy savings potential of CCTWHs in multifamily housing, quantify benefits and potential drawbacks, and extrapolate to other sectors and regions outside of Minnesota by developing custom modeling and assessment tools.

Cofunders: UTD Members, State of Minnesota

Start Date: 6/1/2018
End Date: 2/28/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $495,000
Total SCG Cost: $14,000
Total Cofunding: $481,000
Benefits:

UTD Gas Engine Heat Pump Modeling – Phase 3 (1.12.U.3)

The objectives of this project were to develop new models based on the laboratory and field performance of the recently introduced Yanmar gas engine-driven heat pump, and provide a more accurate prediction of seasonal performance for different climates. The results of this study illustrated the importance of refining techniques to predict performance and identified the key advantages of GHP. The next steps after this study involve updating the GHP Energy Plus performance curves with field data from a parallel project (1.19.F) and investigate the feasibility of GHP systems to meet facility load and more efficient part load operation.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 12/7/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $95,000
Total SCG Cost: $3,800
Total Cofunding: $91,200
Benefits:

UTD Gas Heat Pump Combination Space/Water Heating System Design – Phase 2 (1.17.C.2)

The objective of this project is to develop a smart combi controller that infers the properties of a heat pump and/or water heater and hydronic air handler, and then optimizes the system performance for efficiency and comfort. The goals of the project are to reduce to practice an H3 controller for combination space and water heating systems and to design/build an alpha prototype that utilizes the H3 controller either built into the AHU or as a hub between an AHU and water heater to automate otherwise field-engineered methods for maximizing combi efficiency and delivered comfort.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 06/01/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $24,000
Total Cofunding: $126,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD High Efficiency Thermo Vacuum Commercial Clothes Dryer – Phase 2 (2.17.C.2)

The objective of this project is to develop and test a prototype high-efficiency, natural gas-fired thermo-vacuum clothes dryer and demonstrate the technical and economic benefits over the state-of-the-art dryer. A successful prototype would result in a drying time reduction of up to 75%, fuel savings of 50% or more, and significant emissions reductions, while lowering operating and maintenance expenses.

Cofunders: DOE, UTD Members

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,975,000
Total SCG Cost: $15,225
Total Cofunding: $1,959,775
Benefits:

UTD High Efficiency Ultra-Low NOx Commercial Boiler Burner (2.17.I)

The objective of this project is to field test and deploy a commercial prototype high-efficiency, low-emission, natural-gas-fired burner to meet current requirements in California as well as expected future requirements in non-attainment areas throughout the US. The ultimate goal is to commercialize a high-efficiency commercial burner that is economically and operationally more attractive to the end users than current boiler systems.

Cofunders: UTD Members

Start Date: 6/16/2017
End Date: 1/15/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $300,000
Total SCG Cost: $70,588
Total Cofunding: $229,412
Benefits:

UTD Integrated, Self-Powered, High Efficiency Burner System (1.19.C)

The objective of this project is to develop and demonstrate a grid-resilient, self-powered, fuel-flexible, high-efficiency Advanced Burner Thermoelectric Generator as an integrated system that can be dropped into many types of residential and commercial building space and water heating systems.

Cofunders: UTD Members, DOE, A.O. Smith, Sheetak, II-VI Marlow

Start Date: 7/1/2019
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,060,000
Total SCG Cost: $36,600
Total Cofunding: $1,023,400
Benefits:

UTD Sequestering Non-Condensable Gases for Enhanced Gas Absorption Heat Pump Reliability (1.19.E)

The objective of this project is to design and develop Non-Condensable Gas Isolation Modules and provide research and development support to employ novel, low-cost aluminum heat exchangers to increase system reliability and safe operation, and reduce the cost of any absorption-type heat pump, while demonstrating their performance in a prototype gas-fired absorption GAHP being developed with SMTI.

Cofunders: UTD Members, DOE

Start Date: 7/1/2019
End Date: 06/01/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $800,000
Total SCG Cost: $93,637
Total Cofunding: $706,363
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Triathalon 2030 5-ton Cold Climate Gas Heat Pump (2.19.D)

The objective of this project is to assist in the prototype design of a new five-ton natural gas engine-driven, cold-climate heat pump. The project will involve developing market and functional design requirements, detailed design review, and energy and economic modeling of the proposed design.

Cofunders: UTD Members, NYSERDA

Start Date: 7/1/2019
End Date: 06/01/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $994,368
Total SCG Cost: $3,487
Total Cofunding: $990,881
Benefits:

Westin Bonaventure Gas Heat Pump Demonstration

In this project, SoCalGas is leading an effort to deploy and demonstrate the technical and economic viability of high-efficiency natural gas heat pumps at the Westin Bonaventure, a 1.5-million square foot hotel located in a low-income and disadvantaged community. The goals of the project are to optimally deploy state-of-the-art natural gas heat pump technology into the Westin Bonaventure Hotel, greatly reducing GHG emissions and air quality impacts to local communities and populations located next to and in the areas surrounding this facility, while also demonstrating energy efficiency savings, including a minimum of a 35% reduction in natural gas consumption (target 50%).

Cofunders: SoCalGas Customer Programs, CEC

Start Date: 3/16/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $68,100
Total Project Cost: $1,201,850
Total SCG Cost: $55,000
Total Cofunding: $1,146,850
Benefits:

SUBPROGRAM: COMMERCIAL FOOD SERVICE

GTI Commercial Food Service Decarbonization Cost Analysis

This study was designed to quantify the comparative costs of various strategies to decarbonize commercial kitchens in two types of restaurants: 1) sit-down, full-service restaurants and 2) fast food or quick service restaurants. For each type of restaurant, the research team proposed to compile an inventory of cooking, space conditioning, and water heating equipment and to determine the typical energy usage profiles. Based on this information and energy costs for a selected region, the yearly operations costs could be determined and compared to the cost of theoretically replacing gas-fired equipment with equivalent electric units or substituting the fuel supply with RNG. Due to project delays and lack of access to host sites related to the lockdowns imposed by COVID-19, this project could not be completed on the original timeline.

Cofunders: N/A

Start Date: 7/8/2019
End Date: 12/31/2020
Status: Completed
2020 Funds Expended: $662
Total Project Cost: $50,000
Total SCG Cost: $50,000
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GTI SCAQMD HE/Low-NOx EcoZone Burner Kroger Demonstration

This project will demonstrate a high-efficiency low-NOx ribbon burner at a commercial baking facility located within a South Coast Air Quality Management District environmental justice area. The goal is to demonstrate at least a 25% reduction in NOx emissions and at least 10% energy savings.

Cofunders: SCAQMD, Kroger, SoCalGas Energy Efficiency

Start Date: 11/1/2019
End Date: 1/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,052,000
Total SCG Cost: $200,000
Total Cofunding: $1,852,000
Benefits:

UTD CFS Codes and Standards – Phase 4 (1.16.B.4)

The main objectives of this project are to 1) monitor developments and changes in codes and standards for gas-fired CFS equipment to maintain an understanding of the current and future codes and standards landscape and 2) identify research needs.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $75,000
Total SCG Cost: $9,000
Total Cofunding: $66,000
Benefits:

UTD CFS Codes and Standards – Phase 5 (1.16.B.5)

The objective of this project is to monitor codes and standards activities to identify new research needs for gas-fired, CFS equipment. The research team monitors the proceedings of several technical committees, including ASTM F26 for commercial foodservice, NAFEM Technical Advisory committee, ASHRAE CFS Ventilation, GFEN Technical Advisory committee, and SCAQMD CFS low NOx regulations.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 6/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $75,000
Total SCG Cost: $6,800
Total Cofunding: $68,200
Benefits:

UTD Commercial Food Service Tool and Calculators – Phase 7 (1.13.B.7)

The focus of this project was on the creation of web- and mobile-based tools for usage in the CFS industries. These tools combine the information available from various sources to calculate the economic and environmental benefits of using new, more advanced CFS equipment, including the potential energy and cost savings.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $76,500
Total SCG Cost: $9,000
Total Cofunding: $67,500
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Commercial Foodservice Equipment Demonstrations – Phase 5 (1.14.B.5)

This project is conducting demonstrations of gas-fired CFS equipment to quantify the benefits of the equipment in real-world situations. These demonstrations will address the reluctance of CFS operators to replace existing equipment with newer models due to concerns with cost and the uncertainty of comparable performance with standard models. In Phase 5, GTI will work with industry to identify equipment and potential demonstration locations within sponsor's territories to quantify benefits in terms of cost and cooking performance.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $75,000
Total SCG Cost: $3,750
Total Cofunding: $71,250
Benefits:

UTD Commercial Foodservice Equipment Demonstrations – Phase 6 (1.14.B.6)

This project is conducting demonstrations of gas-fired CFS equipment to quantify the benefits of the equipment in real-world situations. These demonstrations will address the reluctance of CFS operators to replace existing equipment with newer models due to concerns with cost and the uncertainty of comparable performance with standard models. In Phase 6, the team will perform additional short-term demonstrations at test kitchens and restaurant shows and create a mobile test kitchen data acquisition set-up that can be used by sponsors in their test kitchens or events to let their local customers see how well one CFS appliance performs in comparison to another in live cooking demonstrations.

Cofunders: UTD Members

Start Date: 6/17/2019
End Date: 7/16/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $190,000
Total SCG Cost: $24,700
Total Cofunding: $165,300
Benefits:

UTD Commercial Foodservice Equipment Demonstrations – Phase 7 (1.14.B.7)

This project is conducting demonstrations of gas-fired CFS equipment to quantify the benefits of the equipment in real-world situations. These demonstrations will address the reluctance of CFS operators to replace existing equipment with newer models due to concerns with cost and the uncertainty of comparable performance with standard models.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $90,000
Total SCG Cost: $9,000
Total Cofunding: $81,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Gas Fired Warewasher (1.19.B)

The objective of this project is to develop a working prototype of a gas-fired door-type or conveyor-type warewasher in GTI's laboratory and leverage this effort to gain strong interest from a manufacturing partner. Key performance indicators for project success are: develop a gas-fired warewasher prototype, demonstrate efficiency and safe combustion performance in lab testing, and recruit and sign a joint development agreement with a manufacturing partner.

Cofunders: UTD Members, Hobart

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $180,000
Total SCG Cost: $29,000
Total Cofunding: $151,000
Benefits:

UTD Gas Fired Warewasher – Phase 2 (1.19.B.2)

The objective of this project is to develop a working prototype of a gas-fired door-type or conveyor-type warewasher in GTI's laboratory and leverage this effort to gain strong interest from a manufacturing partner. Key performance indicators for project success are: develop a gas-fired warewasher prototype, demonstrate efficiency and safe combustion performance in lab testing, and recruit and sign a joint development agreement with a manufacturing partner.

Cofunders: UTD Members, Hobart

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $175,000
Total SCG Cost: $8,529
Total Cofunding: $166,471
Benefits:

UTD High Efficiency Smart Convection Oven (1.19.A)

The objective of this project is to develop a prototype high-efficiency smart convection oven that increases efficiency by at least 5% and that integrates superior smart operating controls to maximize food preparation quality and consistency. In addition, the research team will work with a manufacturing partner to develop the prototype and assess how the technology could be integrated into its product line.

Cofunders: UTD Members, Blodgett

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $180,000
Total SCG Cost: $44,471
Total Cofunding: $135,529
Benefits:

UTD Low NOx Ribbon Burner – Phase 3 (2.12.M.3)

The objective of this project is to perform technology transfer activities that result in the introduction of a commercial product from one or more major baking industry manufacturers that use the technology developed and patented in prior phases of UTD project 2.12.M.

Cofunders: UTD Members, Flynn Burner, Selas Heat Technology

Start Date: 7/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $125,000
Total SCG Cost: $33,000
Total Cofunding: $92,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Next Generation Commercial Foodservice Burners – Phase 5 (1.14.A.5)

The purpose of this project was to test and develop burner concepts for CFS applications that improve cooking performance, efficiency, and/or emissions, with an emphasis on improving efficiency and emissions of existing burner designs and adapting existing technology to CFS applications.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 9/30/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $175,000
Total SCG Cost: $40,526
Total Cofunding: $134,474
Benefits:

UTD Next Generation Commercial Foodservice Burners – Phase 6 (1.14.A.6)

The objective for this phase of the project is to test and develop combustion systems for CFS applications that improve cooking performance, efficiency, and/or emissions with an emphasis on developing commercialized units. This phase will take the knowledge acquired on burner performance and characteristics from the previous phases and begin designing and constructing prototype CFS units. The goal is taking CFS burner technology from Stage 4: Technology Development to Stage 5: Product Development for prototype units, so that at least three new prototype units are demonstrated with a manufacturer for commercializing.

Cofunders: UTD Members

Start Date: 6/15/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $140,000
Total SCG Cost: $18,375
Total Cofunding: $121,625
Benefits:

UTD Next Generation Infrared Burner – Phase 2 (2.16.A.2)

The objectives of this project are to design, build, and test a prototype high-efficiency, high-performance, fast-start-up, uniform temperature-profile, low-emission infrared burner while working closely with Solaronics, Inc., a leader and manufacturer of gas-fired IR technology and Alantum Corporation, a leader in metal foam materials.

Cofunders: UTD Members, Solaronics, Alantum Corp

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $250,000
Total SCG Cost: $16,000
Total Cofunding: $234,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Next Generation Infrared Burner – Phase 3 (2.16.A.3)

The objectives of this project are to design, build, and test a prototype high-efficiency, high performance, fast start-up, uniform temperature-profile, low-emission infrared burner while working closely with Solaronics, Inc. a leader and manufacturer of gas-fired IR technology and Alantum Corporation, a leader in metal foam materials.

Cofunders: UTD Members, Solaronics, Alantum Corp

Start Date: 6/1/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $300,000
Total SCG Cost: $9,200
Total Cofunding: $290,800
Benefits:

SUBPROGRAM: INDUSTRIAL PROCESS HEAT

Energy Source Options for Industrial and Large Commercial Gas Users (2.20.E)

The objective of this project is to perform a market assessment and techno-economic analysis of possible fuel-switching and decarbonization scenarios for a spectrum of industrial and large commercial subsectors and end-use applications. The ultimate goal is to develop a roadmap basis for natural gas and RNG to support the continued reliable and cost-effective supply of gaseous energy to industrial and large commercial sectors in locations where regulations or other drivers strive to adopt increased decarbonization goals.

Cofunders: UTD Members, ESC

Start Date: 3/1/2020
End Date: 9/30/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $120,000
Total SCG Cost: $10,909
Total Cofunding: $109,091
Benefits:

GTI Burner Exchange to Support Radiative Recuperator Demonstration

The objective of this project is to demonstrate natural gas savings on an industrial furnace for melting aluminum at California Die Casting by preheating combustion air using an advanced radiative recuperator with secondary emitters. The project goal is to demonstrate natural gas savings of at least 25% while maintaining NOx below 30 ppm at 3% O_2 in the exhaust gas. This corresponds to increasing furnace efficiency from 37% with ambient temperature combustion air to over 50% with preheated combustion air.

Cofunders: CEC, UTD Members

Start Date: 9/1/2020
End Date: 9/1/2021
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $1,694,999
Total SCG Cost: $74,999
Total Cofunding: $1,620,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GTI Solar Thermal and Particle Fluid Demonstration

The goal of the project is to successfully demonstrate technology comprising a solar thermal collector and a novel particle thermal storage medium in an industrial heating application. The demonstration will verify the performance, energy savings, and emissions benefits of the technology. This technology was previously demonstrated at the pilot scale of 5kW (1m solar collector). This project will test the technology at the 60kW (12m solar collector) scale, first at the UC Merced campus. Upon successful completion of this testing, the system will be deployed at the USG plant in the Imperial Valley.

Cofunders: ARPA-E, CEC

Start Date: 10/1/2018
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $60,000
Total Project Cost: $3,260,000
Total SCG Cost: $350,000
Total Cofunding: $2,910,000
Benefits:

METRON Energy Virtual Assistant (EVA) Industrial AI Demonstration

This project will demonstrate the METRON-EVA, which utilizes machine learning to optimize industrial processes. All types of data from industrial equipment (boilers, chillers, compressed air, dryers, etc.) are captured and processed by the METRON-EVA platform. The platform allows for "non-intuitive optimization," real-time access to data, and easy reporting. METRON hopes to achieve a payback period of less than 12 months and up to 15% total energy savings (electric and gas combined). The goal is to test/demonstrate the technology at up to three locations. Depending on the site, commissioning can be achieved with minimal hardware installation or remotely (if the customer already has monitoring equipment). Frontier Energy will provide independent, third-party measurement and verification of savings.

Cofunders: N/A

Start Date: 8/31/2020
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $481,460
Total SCG Cost: $481,460
Total Cofunding: $0
Benefits:

Recovering Water and Energy From Industrial Furnace Exhaust (2.20.D)

The objectives of this project are to conduct scaling, equipment sizing, and technoeconomic analyses needed to move a novel new water recovery technology for humid exhaust gases from demonstration to input for commercial deployment. GTI will partner with USG to prepare for first commercial system deployment.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $75,000
Total SCG Cost: $12,000
Total Cofunding: $63,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Advanced Immersion Tube Burner (2.18.B)

The objectives of this project are to design, build, and demonstrate a low-cost, high-efficiency, uniform-heat-flux, simple-to-control, and low-emissions immersion tube burner at the 100,000 Btu/hr laboratory scale. The burner will be capable of meeting increasingly stringent environmental regulations and be an easy-to-operate natural gas-fired technology for the estimated 25,000 natural gas-fired immersion tubes in the US alone in the 24,000 to 8-million Btu/hr size range. The technology will also be applicable to the large number of immersion fire tubes used in oil and gas operations.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $180,000
Total SCG Cost: $37,200
Total Cofunding: $142,800
Benefits:

UTD Direct Contact Flue Gas Heat Exchanger with Innovative Particle Thermal Storage (2.19.A)

The objective of this project is to prove the operation of a 50 kW direct-contact gas-fired cyclone particle heater first in the laboratory and then to incorporate and test the particle heater in the 50 kW solar thermal particle demonstration loop being developed for US Gypsum in Plaster City, California, where the natural gas fired cyclone particle heater and entire particle heat transfer system will supplement solar energy and will provide integrated thermal energy storage.

Cofunders: UTD Members, CEC, DOE

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $3,440,000
Total SCG Cost: $390,000
Total Cofunding: $3,050,000
Benefits:

UTD Energy Recovery Heat Exchanger – Phase 2 (2.16.G.2)

The objective of this project is to demonstrate an advanced recuperator with secondary inserts to preheat combustion air and increase overall system efficiency. Phase 2 will provide final additional UTD Cofunding to a CEC-funded project to demonstrate efficiency improvements on an aluminum melting die-casting furnace.

Cofunders: UTD Members, CEC

Start Date: 7/1/2019
End Date: 06/01/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,405,000
Total SCG Cost: $13,780
Total Cofunding: $1,391,220
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Field Validation of Gas Quality Sensor for Natural Gas – Phase 2 (2.14.O.2)

The objectives of this project are to provide support to GQS licensee CMR as it moves preproduction gas quality sensors through customer testing. GTI will test C-series preproduction sensors from licensee CMR. Fifteen C-series gas quality sensors will be tested by customers (primarily operators and manufacturers of stationary engines). UTD members will have the opportunity to be in the first group of field testers. UTD members will also have the opportunity to be early purchasers of commercial sensors. CMR will work with gas companies to produce GQS versions suitable for gas industry uses. The support of GTI to CMR in this UTD project will accelerate initial commercial sales of the gas quality sensor.

Cofunders: UTD Members, CMR Group

Start Date: 7/1/2018
End Date: 06/01/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $152,000
Total SCG Cost: $16,000
Total Cofunding: $136,000
Benefits:

UTD Sheet Metal Surface Burner Evaluation (2.18.C)

The objective of this project was to evaluate a novel European technology for a sheet metal burner surface combustion burner design being introduced to the commercial condensing boiler markets in the United States. The burner technology is the BLUEJET® burner from Sermeta of France, which claims up to a 40:1 modulation rate. It is also claimed that the three dimensional surface of Sermeta's sheet metal burner improves flame stability and performance, providing reductions in emissions of NOx and CO, up to 50%, and reduced metal temperature by a slight elevation of the flame above the surface.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 1/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $120,000
Total SCG Cost: $28,500
Total Cofunding: $91,500
Benefits:

UTD Thermal Ejector for Water Capture from Humid Exhaust Demonstration – Phase 3 (2.17.A.3)

The objective of this project is to demonstrate a novel and new thermal ejector technology to recover useful process water from humid exhaust gas and increase energy efficiency in a field demonstration at a large industrial facility operated by USG in Plaster City, California. UTD's support is leveraging $1.3 million in cofunding from the California Energy Commission (CEC). This is a new and synergistic benefit of natural gas combustion and the field demonstration will recover up to 100 gallons of water per hour, representing up to 95% of the water in the exhaust gas from the Line 3 drying kiln at USG.

Cofunders: UTD Members, CEC, USG

Start Date: 7/1/2019
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $1,480,000
Total SCG Cost: $16,250
Total Cofunding: $1,463,750
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Zero Carbon Dioxide Emission Combustion at Commercial or Industrial Scale (2.19.B)

The objective of this project was to identify and evaluate methods to cost-effectively capture carbon dioxide from commercial and industrial processes. The goals of this project were to evaluate processes suited for commercial and industrial scale, determine if costs of existing approaches can be lowered, and identify new processes with lower dollar and energy costs.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $125,000
Total SCG Cost: $16,666
Total Cofunding: $108,334
Benefits:

SUBPROGRAM: RESIDENTIAL APPLIANCES

BoostHEAT Thermal Compression-based Gas Heat Pump (1.20.B)

The objective of this project is to develop a "North American" THP product, with a focus on high modulation ratio, integration with forced-air distribution, and adding cost-effective cooling. Project partner boostHEAT has recently established an innovative and new business model in Europe. To successfully enter the North American market, however, this UTD project will address key product development needs. THPs have significant potential for 20% or greater improvement in energy/emission reductions versus best-in-class conventional sorption and vapor compression-type THPs.

Cofunders: UTD Members, OEMs

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $225,000
Total SCG Cost: $26,667
Total Cofunding: $198,333
Benefits:

EnergyPlus Models and Market Analysis for Advanced Residential Heating Systems – Phase 2 (1.16.H.2)

The objective of this project is to build on models and methods developed in the first phase in order to expand the technical and economic analysis of advanced residential heating systems to the entire nation. The overarching goal is to provide decision makers accurate and reliable simulation tools for gas heating systems in order to enable fair comparison with competing technologies.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 1/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $75,000
Total SCG Cost: $15,500
Total Cofunding: $59,500
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Field Evaluation of Indoor Air Quality in Residential Kitchens (1.20.K)

The objective of this project is to determine the effect of cooking emissions on residential IAQ by comparing direct-vent range hoods versus recirculating hoods.

Cofunders: UTD Members, BHE

Start Date: 11/1/2020
End Date: 11/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $335,000
Total SCG Cost: $92,235
Total Cofunding: $242,765
Benefits:

Gas-Fired Binary Fluid Ejector Heat Pump Water Heater (1.20.E)

The objective of this project is to develop and demonstrate Gas Fired Sorption Ejector Heat Pump technology at 12,000 Btu/hr (3.5 kW) capacity in the laboratory and achieve a COP of 2, which equates to twice as efficient as the state-of-the-art on a primary energy basis. This will help retain a high-efficiency role for natural gas for more than 80 million residential users in the U.S. alone of gas fired water heaters. UTD's funding will be leveraged by $1.9M in DOE prime funding.

Cofunders: UTD Members, DOE

Start Date: 7/1/2020
End Date: 7/31/2023
Status: Active
2020 Funds Expended: $0
Total Project Cost: $2,080,000
Total SCG Cost: $19,125
Total Cofunding: $2,060,875
Benefits:

GTI Advanced High Efficiency, Low Capacity HVAC Systems

The goal of this project was to demonstrate that measured home performance or above-code practices coupled with high-efficiency, low-capacity heating/cooling systems in single family homes will show an energy savings in excess of 30% compared to a Title 24 compliant or existing home with standard equipment. The project team is producing 24 months of data from five homes where advanced low-capacity systems were installed, replacing existing equipment with at least twice the capacity of Title 24 compliant or existing systems.

Cofunders: CEC

Start Date: 10/1/2017
End Date: 4/1/2021
Status: Active
2020 Funds Expended: $20,000
Total Project Cost: $900,000
Total SCG Cost: $150,000
Total Cofunding: $750,000
Benefits:

GTI Residential Gas Heat Pump Water Heater Field Demonstration

GTI seeks to advance the commercialization of a residential Gas-fired Heat Pump Water Heater through a five-site field demonstration, extended-life laboratory testing, development of modeling tools, analysis of codes and standards, definition of market barriers for this new product category, and stakeholder outreach events. With assistance from GTI and major water heater manufacturers, SMTI. designed the Gas-fired Heat Pump Water Heater.

Cofunders: CEC

Start Date: 4/17/2017
End Date: 4/30/2021
Status: Active
2020 Funds Expended: $18,811
Total Project Cost: $1,272,355
Total SCG Cost: $188,125
Total Cofunding: $1,084,230
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

GTI Residential Gas Heat Pump Water Heater North America Field Demo

The objective of the project, in partnership with GTI and multiple North American utilities, is to support the development and commercialization of residential gas heat pump water heaters. The demonstration project will deploy approximately 60 such water heaters in order to collect qualitative and quantitative data in regions representing diverse climates and housing characteristics. The goals are to: 1) demonstrate commitment to gas heat pump water heater commercialization and launch; 2) evaluate product readiness across various climates and housing stocks with emphasis on reliability, efficacy, efficiency, installation experience, customer satisfaction and manufacturer/technology developer business capabilities; 3) support utility program development with savings, cost, and installation information needed to quickly develop and deploy programs upon product launch; 4) support timely product launch by communicating in situ performance information to manufacturer with a goal of product launch by 2022; and 5) prime the market by providing hands-on experience to local distribution and installation companies.

Cofunders: Nicor Gas, FortisBC, NEEA, Spire, Enbridge

Start Date: 3/31/2020
End Date: 3/31/2022
Status: Active
2020 Funds Expended: $700,000
Total Project Cost: $6,081,602
Total SCG Cost: $1,081,602
Total Cofunding: $5,000,000
Benefits:

GTI Trane Residential Combi Heat Pump Field Demonstration

The objective of this project is to advance the residential gas heat pump combi technology to preproduction readiness by addressing manufacturing, balance of system/control design and installation, cost, reliability, and field application questions. The goals of this project are to integrate SMTI's thermal compressor (sealed system) design and balance the combined water heating and space heating system (combustion, hydronics, fans, motors, controls, etc.). In addition, GTI seeks to evaluate system performance, reliability, comfort, and compare comfort delivery against air-source heat pump systems. Ultimately, successful completion of this integrated effort will verify consumer benefits, contractor installation issues, equipment and installation costs, and key market barriers.

Cofunders: Enbridge, Intermountain Gas, NEEA, Nicor Gas, Spire

Start Date: 8/31/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $10,000
Total Project Cost: $1,100,000
Total SCG Cost: $200,000
Total Cofunding: $900,000
Benefits:

High Hydrogen-Content Fuel in Residential/Commercial Combustion Equipment (1.20.H)

The objective of this project is to adapt and demonstrate solutions to utilize high-hydrogen blends (> 50% hydrogen by volume) and 100% hydrogen in residential and commercial combustion equipment, by demonstrating multiple solutions in a controlled laboratory environment and leveraging international developments and technology transfer.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $180,000
Total SCG Cost: $18,900
Total Cofunding: $161,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

High-Efficiency Combi System Integrating PV and Self-Power (1.20.G)

The objective of this project is to develop and demonstrate a hybrid residential combined HVAC and water heating (combi) system in the laboratory that uses off-the-shelf appliances and novel controls to integrate gas/electric systems with micro-CHP, energy storage, and renewable energy in order to reduce operating costs and GHG emissions by up to 50% and achieve COPs up to 1.5. This approach will improve energy resilience and help retain a high-efficiency role for NG/LPG in the residential forced-air market. Moreover, it prepares the industry for nascent gas heat pump technology that will also require solutions for system integration.

Cofunders: UTD Members, PERC, Aisin, Enginuity, Mitsubishi, iFLOW, Rinnai

Start Date: 7/1/2020
End Date: 3/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $580,000
Total SCG Cost: $68,073
Total Cofunding: $511,927
Benefits:

Lantec Development of Ultra Low NOx Forced Air Residential Furnace

The goal of this SCAQMD-funded project is to achieve the design, development, performance and operational testing, certification, and commercialization of residential condensing and non-condensing forced air furnaces utilizing Lantec Products' novel MicroNOx ultra-low NOx combustion technology.

Cofunders: SCAQMD

Start Date: 5/1/2019
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $37,531
Total Project Cost: $432,500
Total SCG Cost: $92,500
Total Cofunding: $340,000
Benefits:

Methane Emissions from Tankless Water Heaters (1.18.F)

The objective of this project was to quantify the amount and determine the conditions under which tankless water heaters release unburned hydrocarbons into the atmosphere in order to identify best practices or design features to reduce methane emissions. Models from at least five different manufacturers of tankless water heaters were tested under specific operating conditions and representative use patterns.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 2/28/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $140,000
Total SCG Cost: $33,913
Total Cofunding: $106,087
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

Mitigating Methane Emissions from ResCom End Use Equipment – Phase 2 (1.18.F.2)

The objective of this project is to quantify methane emissions from residential furnaces in order to develop and publish representative methane emission factors. In addition, the project will determine the conditions under which residential furnaces release unburned methane and identify design changes to lessen emissions and communicate these to HVAC industry partners. At least five different models representing an array of residential furnaces will be tested under specific operating conditions and representative use patterns, including both steady and cyclic operation.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $125,000
Total SCG Cost: $17,000
Total Cofunding: $108,000
Benefits:

Rinnai Residential GHPWH Product Development and Testing

The objective of this project is to support Rinnai America Corporation in evaluating a GHP combination space and water heating system (combi) and how it can scale down the technology components to function in the standalone gas heat pump water heater currently under development for the North American field demonstration.

Cofunders: NEEA

Start Date: 9/1/2020
End Date: 3/31/2021
Status: Active
2020 Funds Expended: $120,000
Total Project Cost: $300,000
Total SCG Cost: $150,000
Total Cofunding: $150,000
Benefits:

Robur and SMTI Low Capacity Gas Absorption Heat Pumps: Laboratory Evaluation (1.20.A)

The objective of this project is to evaluate and optimize the performance of low-capacity GAHPs, specifically the Robur K18 (60 MBH) and SMTI 40K (40 MBH), when applied to residential combination space/water heating systems (forced-air heating). These low capacity GAHP systems, sized for residential homes in mild climates or with improved thermal envelopes, must be controlled optimally for comfort and efficiency. How the GAHP performs in addition to how system parameters are optimally controlled (system modulation, space vs. water heating modes, air handler operation, etc.) will be assessed in this experimental effort.

Cofunders: UTD Members, OEMs

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $220,000
Total SCG Cost: $24,000
Total Cofunding: $151,000
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

ThermoLift Combined Heating/Cooling System Technical Support – Phase 2 (1.17.F.2)

The objective of this project is to provide technical R&D expertise and testing as well as performance demonstration analysis to advance the development of a 60 MBH/3.0 ton (18 kW/11 kW) GVHP prototype with heating and cooling COPs of 1.9 (at 47°F/8°C) and 0.9, respectively. Phase 2 will optimize the design and then experimentally test the performance of the combustion system and the entire hot end assembly design. In addition, an entire preproduction GVHP fourth-generation prototype will be lab-tested using standard rating procedures to generate estimates of the AFUE and SEER, which will be used to assess the energy efficiency potential if there are widespread applications of the ThermoLift GVHP for space conditioning.

Cofunders: UTD Members, ThermoLift

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $225,000
Total SCG Cost: $47,250
Total Cofunding: $177,750
Benefits:

UCI Catalytic Burner Retrofitted Water Heater Lab Demonstration

This project is a follow-on to a previous project, which identified several viable flameless radiant burners that could be retrofitted into commercially available water heaters to achieve essentially zero NOx emissions. While these burners have existed for some time in different applications, they have not been implemented into water heaters. Thus, several burner configurations will be procured and installed into water heaters for comparison. The performance of the retrofitted water heaters (i.e., ignition performance, efficiency, emissions, and tolerance to hydrogen content) will be assessed. The study will compare these new configurations against the legacy burner technology commonly found in water heaters. Additionally, the relative tolerance to hydrogen content will be evaluated, providing insight into how these burners can help reduce carbon emissions from natural gas through use of hydrogen/natural gas blends.

Cofunders: N/A

Start Date: 9/1/2020
End Date: 12/31/2021
Status: Active
2020 Funds Expended: $30,000
Total Project Cost: $180,000
Total SCG Cost: $180,000
Total Cofunding: $0
Benefits:

UCI Heterogeneous Oxidation for Zero NOx Heat Study

The purpose of this project was to identify and evaluate the feasibility of "heterogeneous" reaction strategies for replacing water heaters or other appliance burners currently in use. The goal of the project was to survey available heterogeneous reaction technologies and produce a technology evaluation report with recommendations for any viable candidate technologies. As a result, several viable heterogeneous radiant burners were identified that could be retrofitted into commercially available water heaters to achieve essentially zero NOx emissions. While these burners have existed for some time in different applications, they have not been implemented into water heaters. A follow-on project will procure several burner configurations and install them into water heaters for comparison. The performance of the retrofitted water heaters (i.e., ignition performance, efficiency, emissions, and tolerance to hydrogen content) will be assessed and compared against legacy burner technology commonly found in water heaters.

Cofunders: N/A

Start Date: 6/1/2019
End Date: 7/1/2020
Status: Completed
2020 Funds Expended: $15,500
Total Project Cost: $50,934
Total SCG Cost: $50,934
Total Cofunding: $0
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UCI Low NOx Water Heater Retrofit for Hydrogen Blends Development

The objective of the project is to take existing low-NOx water heaters and improve the operational limits of hydrogen tolerance. The goals of the project are to evaluate the modifications that would allow additional hydrogen to be added, carry out the modifications, and demonstrate the amount of additional hydrogen that could be added while still allowing reliable operation. Laboratory testing will be done to evaluate general observations, ignition, flashback, and efficiency. In addition, emissions will be quantified to understand how the NOx, CO, and UHC levels change with increased hydrogen addition.

Cofunders: N/A

Start Date: 10/1/2020
End Date: 6/1/2021
Status: Active
2020 Funds Expended: $19,800
Total Project Cost: $85,000
Total SCG Cost: $85,000
Total Cofunding: $0
Benefits:

UTD Advanced Gas Technology Codes and Standards Monitoring – Phase 7 (1.13.D.7)

The objective of this project was to provide technical support in order to accelerate the use of advanced gas technologies for space conditioning, such as by eliminating gaps or barriers, addressing new and upcoming technologies, or improving performance testing methods, building code requirements, or analytical tools used to assess compliance with energy codes.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 06/01/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $10,000
Total Cofunding: $140,000
Benefits:

UTD Advanced Gas Technology Codes and Standards Monitoring – Phase 8 (1.13.D.8)

The objective of this project is to provide technical support in order to accelerate the use of advanced gas technologies for space conditioning, such as by eliminating gaps or barriers, addressing new and upcoming technologies, or improving performance testing methods, building code requirements, or analytical tools used to assess compliance with energy codes.

Cofunders: UTD Members

Start Date: 6/1/2020
End Date: 8/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $12,500
Total Cofunding: $137,500
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Comparative Assessment of Heat Pump Water Heaters in the Virtual Test Home (1.19.D)

The objective of this project was to compare gas/LPG water heating and electric heat pump water heating on a level basis by characterizing equipment part-load performance in GTI's VTH. The project goals were to characterize at least two electric heat pump water heaters in the VTH, implement the characterizations in EnergyPlus building energy modeling software by updating this software with the relevant peer-reviewed data generated in this project, quantify relative annual water heating energy consumptions and GHG emissions in 15 states across five climate zones, and author a peer-reviewed technical paper for public dissemination that informs readers on predicted energy and environmental impacts of electric, gas/LPG, and hybrid water and space heating.

Cofunders: UTD Members, A.O. Smith, PERC

Start Date: 7/1/2019
End Date: 10/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $107,000
Total SCG Cost: $1,750
Total Cofunding: $105,250
Benefits:

UTD Economical High-Efficiency Residential Gas Absorption Heat Pump with Integrated Cooling (1.18.H)

The objective of this project is to add cost-effective cooling to the low-cost gas absorption heat pump precommercial product developed in UTD project 1.13.F with SMTI that currently only provides whole-house heating and domestic hot water. In this initial phase, the research team hopes to develop an alpha prototype and perform bench-scale experimental testing.

Cofunders: UTD Members, Natural Gas Innovation Fund, SMTI

Start Date: 7/1/2018
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $400,000
Total SCG Cost: $18,600
Total Cofunding: $381,400
Benefits:

UTD High Performance Building Initiative – Phase 3 (1.16.C.3)

The objective of this project was to develop an approach for supporting mixed-fuel, high-performance buildings, covering several fronts, including: zero net energy, renewables, clean power, modeling engines, application guidelines, demonstration houses, and case studies. Project work focused on the methodologies and analysis tools for high-performance homes and home designs that met the goals of the leading methodologies and case studies from selected climate zones.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 6/1/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $105,000
Total SCG Cost: $9,545
Total Cofunding: $95,455
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Integrating Gas Heating and Cooling in Advanced Gas/Renewable Homes (1.18.G)

This project was part of a three-pronged approach (1.18.G, 1.18.D., 2.18.G) to economically develop and evaluate superior system-based solutions to integrate natural gas and renewable energy in residences. The objective was to expand the advanced gas heating and cooling capabilities in the VTH in GTI's laboratory, in order to more rapidly develop, test, and optimize advanced gas heating and cooling options in system-based solutions that increase energy efficiency and reliability, reduce energy costs and GHG emissions, and better integrate natural gas with renewable energy in homes.

Cofunders: UTD Members

Start Date: 6/1/2018
End Date: 3/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $25,000
Total Cofunding: $125,000
Benefits:

UTD Integrating Thermal Energy Storage in Advanced Gas/Renewable Homes (1.18.D)

This project was part of a three-pronged approach (1.18.G, 1.18.D., 2.18.G) to economically develop and evaluate superior system-based solutions to integrate natural gas and renewable energy in residences. The objective was to expand the thermal energy storage capabilities in the VTH in GTI's laboratory, in order to more rapidly develop, test, and optimize thermal energy storage options in system-based solutions that increase energy efficiency and reliability, reduce energy costs, and better integrate natural gas with renewable energy in homes.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 3/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $180,000
Total SCG Cost: $24,545
Total Cofunding: $155,455
Benefits:

UTD Next Generation Residential Gas Dryer Development – Phase 2 (1.15.C.2)

In this project, researchers are investigating next generation gas dryer technologies to exceed Energy Star efficiency levels and develop an early-stage prototype with the most promising technology. The goal will be to find a technology to achieve a 5-15% boost over standard efficiency gas dryers. If any proprietary technologies are discovered during the project, then a UTD invention disclosure will be submitted as well.

Cofunders: UTD Members

Start Date: 7/1/2018
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $150,000
Total SCG Cost: $24,706
Total Cofunding: $125,294
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Next Generation Residential Gas Dryer Development – Phase 3 (1.15.C.3)

The objective of this project is to develop and test in GTI's laboratory a complete working prototype high-efficiency, next-generation residential gas clothes dryer that combines the most promising technologies from prior project phases and optimizes their operation together.

Cofunders: UTD Members

Start Date: 7/1/2020
End Date: 7/31/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $160,000
Total SCG Cost: $28,000
Total Cofunding: $132,000
Benefits:

UTD Residential Cooking Pollutants and Indoor Air Quality (1.17.H)

In this project, researchers conducted an analytical and laboratory investigation on the pollutants (NOx, acrolene, PM2.5) contributed by residential cooking, the impact on indoor air quality, and the implications for range hood design. This large field demonstration identified the need for new residential range burner technology.

Cofunders: UTD Members

Start Date: 7/1/2017
End Date: 7/31/2020
Status: Completed
2020 Funds Expended: $0
Total Project Cost: $80,000
Total SCG Cost: $32,000
Total Cofunding: $48,000
Benefits:

UTD Residential Cooking Pollutants and Indoor Air Quality – Phase 2 (1.17.H.2)

The objective of this project is to conduct an analytical and laboratory investigation on issues and concerns for IAQ and residential cooking based on information from a review of existing literature and data from the previous phase of this project.

Cofunders: UTD Members

Start Date: 6/1/2020
End Date: 6/30/2022
Status: Active
2020 Funds Expended: $0
Total Project Cost: $85,000
Total SCG Cost: $11,333
Total Cofunding: $73,667
Benefits:

- Reliability
- Safety
- Operational Efficiency
- Improved Affordability
- Environmental: Reduced GHG Emissions
- Environmental: Improved Air Quality

UTD Residential Gas Absorption Heat Pump Water Heater – Phase 5 (1.11.H.5)

The objective of this project is to support the development of next generation gas-fired heat pump water heater by eliminating a major cost hurdle for some installations and enhancing reliability/efficiency diagnostics. The goals of this project are to 1) reduce the installation cost/barrier of condensate drain by developing a proprietary method of neutralizing, collecting, and disposing of combustion condensate where access to a sanitary sewer drain is otherwise cost-prohibitive; and 2) improving the onboard diagnostics by exploring the use of Enhanced Solution Level Control which can improve system reliability and long-term performance. Using experience gained in 12 demonstrations of Gen. 1 to 4 gas-fired heat pump water heater precommercial prototypes, GTI and SMTI have identified typical conditions and root causes of poor efficiency and/or product failure.

Cofunders: SMTI, UTD Members

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $170,000
Total SCG Cost: $42,491
Total Cofunding: $127,509
Benefits:

UTD Residential Kitchen Cooking Ventilation Effectiveness – Phase 2 (1.15.G.2)

Despite most home kitchens having a ventilation system above the stove, most home owners do not use the system unless excess smoke is being produced and many existing systems are ineffective at capturing food and combustion emissions. The objective of this project is to evaluate kitchen cooking ventilation effectiveness.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 1/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $70,000
Total SCG Cost: $31,080
Total Cofunding: $38,920
Benefits:

UTD Thermoelectric Generator for Self Powered Water Heater – Phase 3 (1.17.B.3)

The objective of this project is to develop and prove the concept of a novel self-powered natural-gas-driven tankless (instantaneous) water heater with ultra-low emissions <5 ppm NOx, and with excess power capability or a primary COP of >1.0, by incorporating a novel new heat pump configuration with a Thermoelectric Generator-Heat Exchanger design.

Cofunders: UTD Members

Start Date: 7/1/2019
End Date: 7/31/2021
Status: Active
2020 Funds Expended: $0
Total Project Cost: $300,000
Total SCG Cost: $80,000
Total Cofunding: $220,000
Benefits:


SoCalGas
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